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STEEL FREIGHT CAR DESIGN.

BY C. A. SELEY.

In an address delivered before students and professors of Purdue University, Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, presented arguments worthy of the widest circulation. The very successful cars of his design now running on the Norfolk & Western, the Seaboard Air Line, the Louisville & Nashville and the "'Frisco System" support the views of Mr. Seley. These cars have all been illustrated in this journal. The portions of the address referring to steel frame cars are reproduced as follows:

Steel underframe cars do not employ truss rods as a rule. The sills are generally deep in section in the center, tapering to a lesser depth at the ends, the shape employed being generally called fish-bellied. This is not strictly correct, as the ideal shape should take into account the reaction of the load beyond the bolsters in determining the section at any point between the bolsters. This construction gives the greatest economy of material used in the sills, and while readily produced by the builders they are sometimes an embarrassment to the railroads, when it is necessary to repair them on account of a lack of facilities. They are either a pressed shape or a sheared plate, reinforced with angles at the edges. Very deep sills also interfere with free inspection under the car.

Suppose we undertake to make the entire framing of a box car of steel, working in the truss idea, not using truss rods nor girder side sills. We will use a steel channel for the lower chord or side sill and an angle for the upper chord or plate. For the verticals and diagonals, which in car building parlance are posts and braces, angles, channels, I beams and Z bars are applicable, as follows: Angles for corners, I beams for end intermediate posts, which are of special value for strengthening the ends of the car, the notoriously weak part of a wooden car. Channels for door posts and end plates and channels or Z bars for side posts and braces and end braces.

Investigation of a steel side framing for a car will surprise one, to find how light a section can be used for the vertical strength required. This is due to the great depth available for the truss. There is, however, another element to consider, which is not met with in bridge calculations. Cars have to be constructed to carry flowing loads, as of grain, coal, etc., and the sides have to stand a stress which has a bulging effect. A side framing, calculated only for the vertical load will not be strong enough, although it is by no means necessary to use sections heavy enough to withstand the calculated side thrust of the flowing load. The reason for this is an important one. It has been noted in the analysis of a wooden car framing that the tension members were relatively weak, being light rods. The wooden posts have to stand the side thrust strains. In a steel car frame as above described, the members being riveted top and bottom, the verticals are tension members in fact, and their own inherent strength against bulging is reinforced by their lading giving them a bowstring effect.

One railroad built a lot of box cars, using the lightest standard weight of 3-in. channel for the intermediate verticals and diagonals of the side framing. There was no question of the vertical strength, but the design had no precedent by which to judge of the effects of lateral thrust. These cars have been in service about four years, and numerous examinations have disclosed no signs of bulging, and as the road in question has recently added a large lot of these cars to their equipment, there was probably no mistake made in the original design in trusting to the light sections used.

Prior to making that design some interesting experiments were made with a wooden model, which consisted only of the side frames and floor, supported on the four points corresponding to the ends of the body bolsters. In the model, which was 1-12 size the sills, and plates were cut down so as to have almost no strength as beams. The verticals and diagonals were notched over the top and bottom members, the whole framing and floor weighing but 2¾ lbs. This was filled with cast iron washers, arranged symmetrically, corresponding to the lading the full length of a car, and when the experimenter got tired of putting in washers it was found that this frail construction was carrying 215 lbs. The deflection could be plainly seen and measured by suitable lines. The model was so well made that when the lading was removed it came back almost to the original lines. The load was replaced and then removed only from the ends beyond the bolsters, and the center deflection showed an increase by reason of the loss of the reaction of the end lading. The end loads were then replaced and then one-half of the load was removed, beginning at one end. This was to see the effect of maximum unsymmetrical lading in the center panel, which was opened as in a car door way, and not provided with the diagonal bracing used in bridge construction. The lines showed the S curve or shearing tendency very plainly, but the amount of the deflection and general behavior of the model while undergoing these and other unsymmetrical loading arrangements led to the belief that no special provisions for taking care of this shear need be made in the car framing. The center sills have to be beams or else be under trussed, their support being the bolsters, although, if necessary, the sides can be made to help them. The lower chord or side sill of the cars above mentioned was an 8-in. channel, that depth being employed for other reasons connected with the car construction, and not on account of the necessity for that depth of section as a truss member. The vertical stiffness of these sills and the center sills takes care of the shear due to any unsymmetrical lading ordinarily found in box cars.

This side truss construction is applicable to other types of cars, such as hopper bottom and flat bottom gondolas, used for transporting coal, ore, sand, etc. These types have a full unbroken side for the application of an uninterrupted truss. Provisions against bulging must be made by cross-tieing at the top or by special means at the bottom.

Over 10,000 cars have been constructed and are running, demonstrating the correctness of the principles involved in the side truss construction, and a considerable number are on order at various building shops.

Particular attention has been paid in this paper to the steel frame box car, because it is regarded as the most important type on account of the number employed. It is desirable that a standard design of body should be made of the American Railway Association standard dimensions which could be used by all railroads, they to use their own particular designs of trucks. The importance of such standardization is obvious to all students of railway equipment maintenance. Whatever the arguments may be against steel, in the frames of all types of cars, the over-exaggerated fears of corrosion, difficulty of handling repairs with ordinary car labor, etc., the fact remains that on roads that have tried it steel has demonstrated its applicability and economy in maintenance, and in time will as generally supplant wood in car framing as it has already done in railway bridges. It will take a long time to do this, but the evolution is nevertheless quite sure, and I look for it largely on the lines of the simple, direct applications which I have indicated.

Aside from the desirability of steel in car framing for the reasons stated heretofore, there is another important one. We need a very heavy backbone in cars with the present and increasing use of heavy engines. In the last ten years the average tractive power of locomotives has been greatly increased, and consequently the tonnage of trains is much greater. It has been found in these long trains that very severe shocks occur, back in the train, from the slack running up or out, as the case may be. The comparatively light draft gear of the old cars suffers much from these, as well as from the direct pull of the heavy engines now in use. The benefit of a direct steel column in the car framing to withstand these heavy pulling and buffing shocks is very evident. This consideration will justify the use of steel for even the medium capacity cars, as they are hauled in the same trains and by the same engines as the higher capacity cars. There is great mortality nowadays among the old light cars on railroads that use heavy power, and our repair tracks are full of bad order cars with the draft gear disabled, ends knocked out or pulled out. It is difficult in the very best practice in designing cars with wooden draft gear to provide a construction that will stand. This also shows the necessity for the stronger construction afforded by the use of steel.

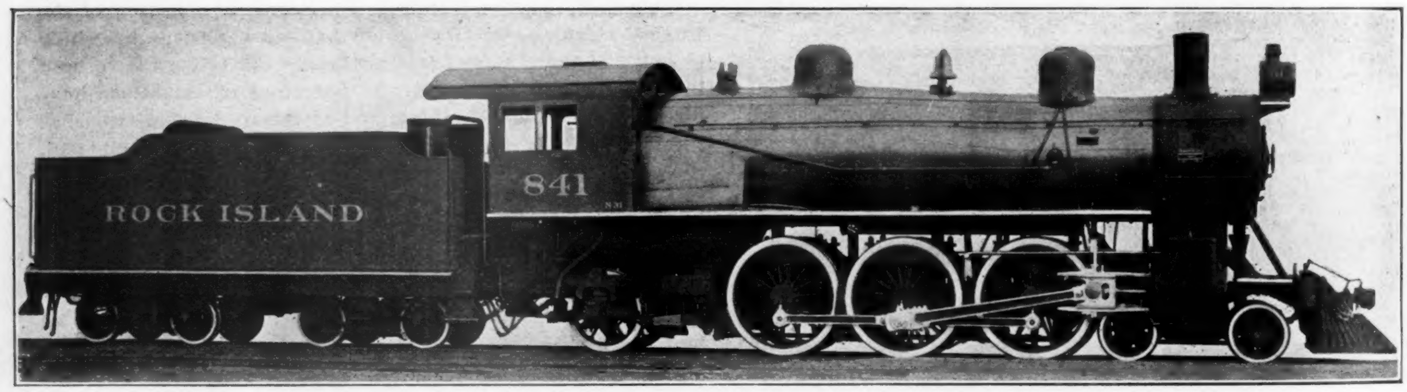
I have seen an excellent man use a 6-in. instead of a 12-in. diameter emery wheel, and he thought he was saving $3.60 a month in supplies, but was really wasting $30 a month in wages.—*Mr. Harrington Emerson, Western Railway Club.*

PACIFIC TYPE PASSENGER LOCOMOTIVE.

Chicago, Rock Island and Pacific Railway.

The proposed standard locomotives recommended by the motive power committee of the Rock Island System were described in the March number of this journal, page 84, the five principal designs being illustrated by diagrams giving the leading dimensions. Several of these locomotives have already been built, the first chosen for illustration being the Pacific type passenger locomotive, as built by the American Locomotive Company at the Schenectady Works. Fifteen of these locomotives have now gone into service and are doing excellent work. By comparing the dimensions with those given in the tabular supplement accompanying the May number of this journal, of the current volume, it will be seen that this is not a remakably heavy locomotive. By comparing the dimensions with those of the fifth column of the proposed Rock Island standards in the March number it will be noted that comparatively few changes have been made from the details recommended by the committee.

This locomotive has a deep fire box, liberal heating surface, and is intended for service upon divisions with steep grades. The previous passenger locomotive of this type for this road built at the Brooks Works in 1903, was illustrated in this journal in October of that year, page 351. The present locomotive has 31,000 lbs. tractive power as compared with 28,600 lbs. for the earlier design. In the new standard Pacific type locomotive the firebox is 67 ins. in width, which is the adopted standard for the width of all the standard fireboxes. This locomotive has outside journals for the trailing wheels; it has supplemental frames under the firebox and differs in a number of its details from the earlier design. It has Richardson balanced slide valves and alligator crossheads. The following table presents the leading dimensions:



PACIFIC TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

T. S. Lloyd, *General Superintendent of Motive Power.* American Locomotive Company, *Builders.*

PACIFIC TYPE PASSENGER LOCOMOTIVE.

Chicago, Rock Island & Pacific Railway.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive power	31,000 lbs.
Weight in working order	206,000 lbs.
Weight on drivers	133,800 lbs.
Weight of engine and tender in working order	351,000 lbs.
Wheel base, driving	12 ft. 4 ins.
Wheel base, total	32 ft.
Wheel base, engine and tender	61 ft.
RATIOS.	
Tractive weight ÷ tractive effort	4.31
Tractive effort x diam. drivers ÷ heating surface	638.
Heating surface ÷ grate area	74.8
Total weight ÷ tractive effort	6.64
CYLINDERS.	
Kind	Simple.
Diameter and stroke	22 by 26 ins.
Piston rod, diameter	3¾ ins.
VALVES.	
Kind	Richardson balanced.
Greatest travel	6 ins.

Outside lap	1 in.
Lead at ¼ stroke	¼ in.
WHEELS.	
Driving, diameter over tires	69 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ and 9 by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	49 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Extended wagon top.
Working pressure	200 lbs.
Outside diameter of first ring	68⅝ ins.
Firebox, length and width	96 by 67 ins.
Firebox plates, thickness	⅝ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	328-2 in.
Tubes, gauge and length	No. 11, 18 ft. 7 ins. long.
Heating surface, tubes	3,175 sq. ft.
Heating surface, firebox	179 sq. ft.
Heating surface, total	3,354 sq. ft.
Grate area	44.8 sq. ft.
Exhaust pipe	Single.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 5¼ ins.
Center of boiler above rail	113½ ins.
TENDER.	
Tank	Water bottom.
Frame	13-in. channels.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,500 gals.
Coal capacity	13 tons.

A VERY FAST RUN.

When the distance from Chicago to Buffalo, over the Lake Shore & Michigan Southern Railway, was covered at an average speed of 65.07 m.p.h. on Thursday, October 24, 1895, a world's record was made for this distance. On June 12 and 13, 1905, a train of three private cars was run over the same road, a distance of 525 miles, at an average speed of 69.53 m.p.h., including stops and an average speed of 70.94 m.p.h. excluding stops. This was a special train composed of three officer's cars weighing 175 tons back of the tender. The accompanying table contains the official record of the speeds over each division, the figures having been taken from the train dispatchers' records. The locomotives of the 4600 class are 2—6—2 type, illustrated in this journal in 1901, page 69. Locomotive No. 5003 is of the 4—6—0 type, illustrated in 1899, page 343, and were the first locomotives of this type designed by Mr. W. H. Marshall when superintendent of motive power of this road. Locomotive No. 3707 is of the new class K, 2—6—2 type, illustrated in 1904, page 413, and is the heaviest passenger locomotive in the world at the present time. That this very heavy locomotive made such speed is worthy of special record. The figures presented include the length of each division, the time of departure and arrival, the time over each division, the distance and speed in miles per hour. All of the locomotives concerned in this remarkable run were built at the Brooks works of the American Locomotive Company.

That the record made last June did not involve any special preparation, whereas that of October 24, 1895, required extraordinary preparation, is a fact worthy of note. The record follows:

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Westbound, June 12, 1905. Private cars 201, 203, coach 340.

	Time over division.	Distance.	Average speed per hour.
Engine 4692.			
Lv. Buffalo.... 5:15 a.m.			
Av. Cleveland. 7:50 a.m.	*2 hr. 35 min.	183 miles.	*70.8 miles.
Engine 4665.			
Lv. Cleveland.. 8:00 a.m.			
Av. Toledo.... 9:33 a.m.	1 hr. 33 min.	108 miles.	69.66 miles.
Engine 5003.			
Lv. Toledo.... 9:36 a.m.			
Av. Elkhart...11:30 a m.	1 hr. 54 min.	133 miles.	70.00 miles.
Engine 695.			
Lv. Elkhart... 11:33 a.m.			
Av. Chicago... 1:05 a.m.	1 hr. 32 min.	101 miles.	65.86 miles.

*Including a 2-minute stop at Erie .

Average speed, 525 miles, including stops, 67.02 m.p.h.

Average speed, 525 miles, excluding stops, 69.69 m.p.h.

Eastbound, June 13, 1905. Private cars 201, 203, coach 340.

Engine 695.			
Lv. Chicago... 6:30 a.m.			
Av. Elkhart... 8:22 a.m.	1 hr. 32 min.	101 miles.	65.86 miles.
Engine 4661.			
Lv. Elkhart... 8:24 a.m.			
Av. Toledo....10:18 a.m.	1 hr. 54 min.	133 miles.	70.00 miles.
Engine 4665.			
Lv. Toledo....10:20 a.m.			
Av. Cleveland 11:51 a.m.	1 hr. 31 min.	108 miles.	71.20 miles.
Engine 3707—685.			
Lv. Cleveland..11:55 a.m.			
Av. Buffalo... 2:25 p.m.	*2 hr. 30 min.	183 miles.	*73.20 miles.

*Including a 3-minute stop one mile east of Dunkirk.

Average speed, 525 miles, including stops, 69.53 m.p.h.

Average speed, 525 miles, excluding stops, 70.94 m.p.h.

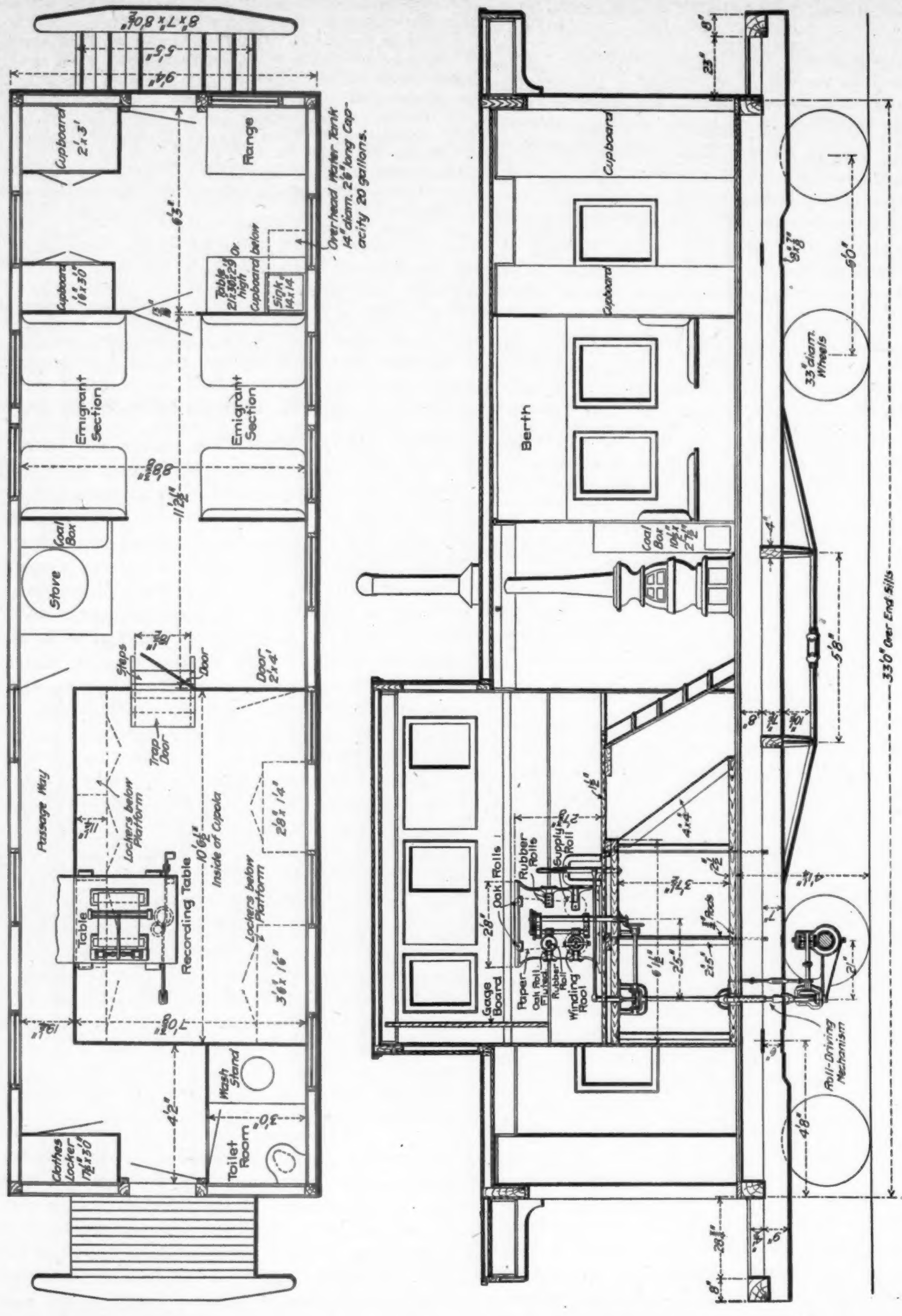
STEEL FOR PASSENGER CARS.

Every railroad wreck that has as one of its horrors the burning to death of imprisoned passengers calls attention afresh to the steel car and the larger place it must take in the construction of passenger as well as freight cars. The resistance of steel to the terrific impact of the derailed train at Mentor, Ohio, recently might have saved a number of lives. Certainly with steel cars there would have been no kindling pile and no charred bodies. The purchase of steel cars for the New York Subway was prompted chiefly by the desire to make the best provision against fire, derailment and collision. The latest of the tube railways in London is equipped with steel cars for the same reason. It would seem that the large death lists from fires on steamers, in public halls, hotel buildings and railroad wrecks in the United States in the past 18 months have given sufficiently terrible emphasis to the need of a larger use of non-combustible materials for buildings, cars and vessels.

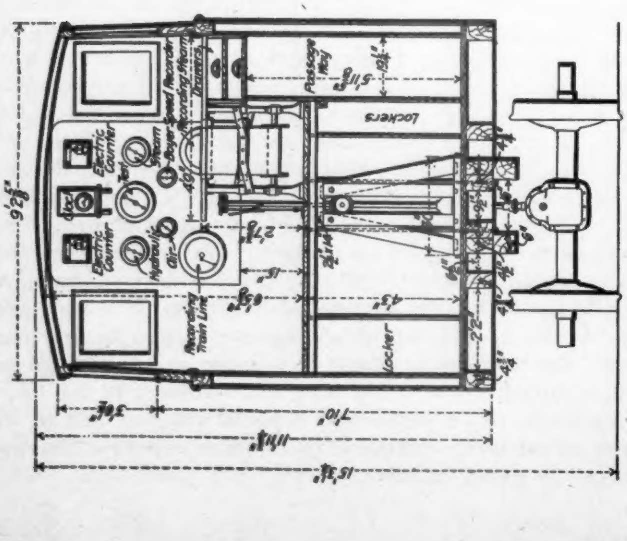
Steel as a material of construction has made its way because of its strength, its resistance to the elements, or because of its economy of space, or for other reasons appealing to the engineer. It is evident, in the apparently increasing dangers of crowded modern life, that steel will come into increasing use because it affords greater security to human life. In the past 20 years the metallurgical engineer and the mechanical engineer have worked together to cheapen it so that the civil engineer could employ it more freely. It is safe to predict that a large factor in the steel tonnage of the future will arise from uses which are optional to-day, but which public sentiment will then make compulsory.—*Iron Age.*

CRANES FOR COALING LOCOMOTIVES.—Our experience with the self-propelling 3,000-lb. crane at places where we do not have room or the means for installing a modern coal plant has reduced the cost of our coal, and our loading expenses, from 13 to 6 men, by the installation of a central self-propelling crane. It will clean out a gondola car, with the exception of the corners, and 15 minutes' work on the part of a man with a shovel will get the coal out of the corners. It will also take the ashes out of a level track or pit, and it is quite handy in every way. I mention these things with the hope that some of our members may profit by the suggestion.—*Mr. J. F. Walsh, before Master Mechanics' Association.*

DETROIT TUNNEL.—The construction and the electrification of the Detroit Tunnel Line from Windsor, Ontario, to West Detroit Yards, Mich., for the Michigan Central Railroad, has been placed in charge of an advisory board of engineers, consisting of Mr. William J. Wilgus, vice-president of the N. Y. C. & H. R .R. R.; Mr. Howard Carson, consulting engineer, and Mr. W. S. Kinnear, chief engineer of the Tunnel Company. The chief engineer will be in direct charge of construction, reporting to Mr. H. B. Ledyard, chairman of the board of directors, on executive and financial matters, and to the board of advisory engineers as to plans, specifications and methods of doing the work.



PLAN AND LONGITUDINAL SECTION THROUGH DYNAMOMETER CAR, SHOWING ARRANGEMENT OF APPARATUS—NORTHERN PACIFIC RAILWAY.



CROSS SECTION THROUGH DYNAMOMETER CAR.

DYNAMOMETER CAR, NORTHERN PACIFIC RAILWAY.

The new dynamometer car built by the Northern Pacific Railway combines features which have been employed in other cars previously put into service. It employs the raised location of the operating table which was used in the New York Central dynamometer car which was illustrated in the June number of this journal, page 198. The operator's platform in the Northern Pacific car is 10 ft. 6 ins. x 7 ft., with a passageway on one side of the car. The platform is raised about 4 ft. above the floor of the car and the cupola gives the observers a clear view in both directions, provided the cupola is not enveloped in smoke from the locomotive.

For transmitting and measuring the drawbar pulling and buffing stresses, hydraulic apparatus is used, this being similar to the equipment of the dynamometer cars of the Burlington and of the University of Illinois. The drawbar stresses are received

by an oil cylinder communicating by piping to the recording table. These pipes lead to a pair of small cylinders, in tandem, having a piston rod in common. The movement of this rod is opposed in each direction by a carefully calibrated spring, the loads for small increments of deflection being known. The pen arm records the deflections of these springs under the pressure from the cylinder operated by the drawbar. The engraving clearly illustrates the paper driving mechanism and the location of the gauge board.

This car was originally a caboose, 33 ft. long, strengthened and practically rebuilt. The plan shows the arrangement of the interior and the facilities provided which are adapted to comfortable living for the attendants during relatively long periods.

APPRENTICE SYSTEM.—GRAND TRUNK RAILWAY.

Mr. W. D. Robb, superintendent of motive power of the Grand Trunk Railway, described the apprentice system of that road before the Master Mechanics' Association as follows:

I have realized for some time that the teaching of our employees, and especially our apprentices, for positions of responsibility in the motive power department, was a question which could not be neglected, and the system which we have, while it has been in force on the Grand Trunk for a number of years—I went through it when I served my time—latterly it dropped away; but I found that there was a shortage of material, that we ran out of men, and I had difficulty in obtaining men for positions of responsibility, difficulty even in obtaining men for good positions as workmen, and I decided that it would be necessary to educate our own men. I therefore introduced the apprentice system, starting in with indenture papers. Every boy is indentured. He signs himself and is signed by his parent or guardian, and these indenture papers prevent them from joining any union as long as they are serving their apprenticeship. We had difficulty in obtaining apprentices when we started, a great deal of difficulty; but after the system became known and the parents realized the benefits which the boys would receive, that difficulty disappeared. For your information I will just tell you the number of apprentices we have. At Montreal we have 234 machinists, 90 apprentices, a percentage of 38; at Toronto 64 machinists, 25 apprentices, a percentage of 39; at Stratford 289 machinists, 110 apprentices, a percentage of 38; at Fort Gratiot 110 machinists, 60 apprentices, a percentage of 54. We have an average of 40 per cent. of apprentices.

At first the system was voluntary—that is, the drawing and the teaching of apprentices; but I found that would not do, and it was made compulsory. An apprentice boy is given to understand when he comes in that he has to pass an examination. Unless he passes that examination successfully he cannot enter the service. The schools start in October and they end in April. The list of apprentices is given to the teachers. The teachers are provided by the company, as are the room, the light and the heat, and all that the apprentice has to do is to buy his own instruments. The list of names is given to the teacher of every apprentice in the works, and the roll is called. Every boy who is absent has his name sent to the master mechanic the next day as a warning, and he has to give a reason for his absence. If his reason is good it is accepted; if not, he is censured. If he does not attend he is discharged. The boy has to pass an examination before he receives his increase. All the increases received are on his indenture papers. We deduct from his daily rate and keep so much—a percentage—until he is out of his time. When he is out of his time that money is paid to him, and along with it a bonus. We have found that by having that system of indenture and holding the money back we are able to hold our apprentices, which we formerly were not able to do. These boys have to pass an examination before they receive their increase. The examination takes place before the shop expert, and it includes drawing and all the subjects of the system of examination. It is a written examination, and it all comes up before the master mechanic, receives his approval, and then comes to me. If his examination is not satisfactory he is sent back for six months and receives no increase. If he fails on his second examination he is discharged. In addition to teaching drawing we are now teaching them theory, applied mechanics and mathematics. We have no difficulty, as I said before, in getting apprentices for machinists, but we did have difficulty in getting apprentices for boiler makers, blacksmiths and rivet boys and steam hammer boys, and it was necessary to take on younger boys and boys who did not have sufficient education to pass the apprenticeship system. We have now introduced a school along with the drawing and the other training to teach these boys, writing, arithmetic, reading and spelling, and they come in younger than the other apprentices. They have to pass examinations on that as well as on the other, and after they pass that examination they are brought forward as machinist apprentices. In the spring of the year, at local points, prizes are given for the best standing. That is, locally. In addition to that prizes are given for the whole system, for which the boys compete over the entire system. Now, I want to say that I can assure this association that we find a very great deal of benefit from the system which we have. In fact, we have reached the point now where we are able to get sufficient material for promotion on our own system without having to go outside for it.

AN ECHO OF THE INTERNATIONAL RAILWAY CONGRESS.

Referring to the recent Washington meeting of the International Railway Congress, this journal in its June number said: "The value of the official discussions would have been much greater if those other than delegates were permitted to know exactly what was said in the meetings. The reports of the discussions, after the censors had finished with them, were robbed of much of their value and it is to be hoped that at some future time the star chamber character of the discussions may give place to a more modern and enlightened plan, as there can be no satisfactory reason at this day and date for discussing technical railroad subjects behind closed doors." A similar criticism from a correspondent of the London *Times* was expressed in that publication as follows: "The official reports, as published from day to day in the journals of the Congress, were ridiculously inadequate, especially for the important technical journals of Europe and America, and the exclusion from the meetings of the contributors on engineering subjects to those publications seems, from both a British and American point of view, to have been the greatest possible mistake. By excluding the technical press the Congress lost an opportunity to make its work known, which nearly all of the British and American delegates who have been consulted on the subject have regretted. If the International Railway Congress is to fill its proper place in connection with the advancement of transportation interests this secretive policy must give place to one consistent with the dignity and the aims of this organization. The organizations which occupy the highest posts are those the discussions of which are cast widely before the world, while fresh, by the technical press, and in this country, at least, the press has exerted a powerful influence in improving the work of technical organizations by suggestions of the technical press itself."

One lesson of the Washington convention is the desirability of removing this obstruction. Another lesson is the impossibility of delegates, representing railroad interests in various countries of the world, ever getting together in agreement upon the conclusions in matters of practice without robbing those conclusions of all value and even all interest. What the International Railway Congress should do is to open its meetings, improve its discussions, place those discussions widely before the world and allow those who wish enlightenment from this source to secure it and adapt it to their own needs. That which delegates of 46 countries, all over the

globe, can agree upon as "conclusions" is the least important element to be gained from such studies as this organization is able to make. Great good is accomplished by the International Railway Congress, but those who are directing its career should be brought to think of its loss of influence due to these causes.

SERVICE AND SAFETY OF M. C. B. CAST IRON WHEELS.

In a discussion of the question, "How does the M. C. B. cast iron wheel show up in service as regards flange breakages?" Messrs. R. L. Ettinger and G. L. Fowler offered the following before the Master Car Builders' Association:

Mr. Ettinger.—The 1904 cast iron wheel has not been in service long enough to state that the design is perfect and will remedy all defects in former patterns, nor was it claimed by the committee presenting it that they believed it to be the only design that would give good, satisfactory service; but the 1904 wheel was presented as the best they had to offer by a very representative committee of this association, ably assisted by a committee representing a majority of the largest wheel makers in the United States. These manufacturers must be satisfied that they are on the right track, as I have recently heard from a number who are now prepared to furnish this design, one writing that the 700-lb. pattern was made shortly after the convention last year and a great many thousand wheels from it put under cars of 100,000 lbs. capacity from which they have had practically no complaint.

The company with which I am connected put 8,000 wheels from this design in service last winter under 100,000-lb. steel coal cars. These cars are operating on some very heavy grades, and up to the present time we have not had any failures. Of the lighter wheels for 60,000-lb. cars we have a larger number running.

On a road in the west they had a number of very high coal cars that were giving a lot of trouble from breaking wheels, and it was decided to try the new M. C. B. design. The wheels were changed under some 200 cars, and I am told that none of the new wheels have failed. In this same connection and leading up to the change there were some tests made at Purdue University of types of wheels in general service and wheels made from the new M. C. B. pattern. All of the results were in favor of the new design.

The breaking of flanges will be reduced to a minimum for cast iron wheels by the addition of 1/8 in. more metal on the outside. This increase will amount to but little more than 1-16 in. on a line with the wheel tread, and this will not affect guard rails set at 1¾ in. any more than a driving wheel having the common distance of 53¼ in. between flanges, or a car wheel and rail that have a combined wear of 1-16 in. The co-operation of our road departments could very rapidly bring about the same relative conditions that now exist.

On going into this question very carefully with our engineering department we could not find any objection from their point of view to making the change in the wheel and using them on the tracks as now laid, or on their part to increasing the clearance between main and guard rails to 1⅞ in. on all new or repair work, and this has been decided upon.

We took this matter up with our engineering department with some hesitancy, because there had been so much said about the objections we might expect to meet with, but in place of objections found a perfect willingness and desire in that department to do anything the mechanical department asked with the view of better wheel service and fewer failures.

Mr. Geo. L. Fowler.—I have not had the privilege of having had charge of any cars of 100,000 lbs. capacity using cast iron wheels, but I have been commissioned on two or three occasions to look into the service of cast iron wheels under various conditions. The position, it seems to me, as it stands to-day, is that there is an uncertainty in regard to the advisability and the safety of using a cast iron wheel under a car of 100,000 lbs. capacity. Under a 60,000-lb. capacity car there is no doubt whatever but that it is all right. Under an 80,000-lb. car they seem to think that it is just about on the verge of the upper limit. With regard to the 100,000-lb., the general sentiment, as I find it through the community, is one of doubt. To remedy these defects, changes have been made in brackets, in the location of the plates and the thickness of the metal, in order to strengthen the wheel, and these have been to a certain extent successful, but there have been a number of cracks, and some very peculiar cracks developed in action on mountain roads. It has been found that the brake action in heating the wheel is apt to produce an internal crack that no inspector can see, and it works its way to the outside, breaking in detail, as though there were an inherent defect in the wheel as it came from the foundry, while it is really due to the brake action, because the same thing has been reproduced by subjecting a wheel to a thermal test; not the thermal test with a thick band of metal, but with a thermal test of about ¼ in. molten iron, heating it about as the brake shoes would heat, and reproducing an internal crack which cannot be seen by any kind of an inspection.

Now, with regard to the strength of the cast iron wheels: Professor Goss, at Purdue, recently took some cast iron wheels and put them in his testing machine, laid them flat and forced a square pressure bar down against the flange, holding it in place so that it could not back off, with some rollers to overcome the frictional resistance between the bar and a supporting angle back of it; and with this he pushed the flange down off the wheel. He told me the other day that a normal wheel broke at 70,000 lbs. pressure. I heard of this a few weeks ago, and thought I would like to corroborate those figures for myself and try to ascertain the relative strength of a steel-tired wheel or a steel wheel. I wrote to Prof. Goss, asking him if he thought that he could do the work on his testing machine, and calculated that it ought to take about four times or four and a half times as much pressure to push off the steel flange as a cast iron flange. I based my calculation on the comparative tensile strength of the metals, which for cast iron wheels runs from 28,000 to 30,000 lbs. and for the steel tire runs from 112,000 to 125,000 lbs. I made some tests a short time ago of the tensile strength of steel tires and found that they broke at from 112,000 to 113,000 lbs, per sq. in. Similar specimens from the tread of the Schoen steel wheel broke at stresses ranging from 118,000 to 123,000 lbs. per sq. in.; so that there is not much difference between the two.

Professor Goss said he was unable to do the work in his machine, so I requested the Schoen Steel Wheel Company to lend me their press, which has 1,000 tons capacity; I procured a cast iron wheel that the makers knew I was going to use for that purpose, and they sent me one that was a little thicker on the flange than the law really allows, with a chill that measured about 1/8 in. in the throat, so that there was a backing of good solid gray iron in behind there to stand the stress. My figures on that are not, of course, absolutely accurate, because I was working on a large press where I had to allow for the weight of the head and also for the frictional resistance of the packing, but as the frictional resistance of the packing has been pretty thoroughly worked out, there is probably not much error in my figures. The method used was to bolt the wheel firmly to the base of the press and to force a plunger bar down against the flange. The bar was prevented from backing away by a stiff angle bolted to the bed, the rubbing surfaces between the two having been well greased. This is essentially the same method as that used by Prof. Goss. I broke the flange of that chilled iron wheel at a pressure of 116,000 lbs., and it fractured silently with no apparent recoil. The flange of the Schoen steel wheel broke at 526,000 lbs., showing that there is not very much difference in the relative value of the strength of the flanges and the tensile strength of the metal that was in the wheels. In the case of the cast iron wheel under consideration, I did not measure the tensile strength. At the present time I am engaged in an investigation to ascertain what the vertical stresses are on a wheel, and I would suggest that we are very much in the con-

dition of a man who would attempt to build a bridge without knowing anything about the load that that bridge was going to carry. You are running your wheels at all kinds of velocities, with all kinds of loads, over all kinds of tracks, and there is no one that knows anything at all about what the actual flange stresses are. If the flange of a cast iron wheel is only worth 70,000 lbs., which Professor Goss tells me is the normal stress, it looks to me as though we were running very near the danger line when we are putting it under cars of 100,000 lbs. capacity, high, as these cars are when loaded away up higher than the old box car used to be, hauling them over all degrees of curvature and all kinds of track, without knowing anything at all about the stresses to which we are subjecting them. I would suggest that it would be a very appropriate thing for this association or some railroad or combination of railroads to investigate what the horizontal stresses are on a wheel when it is in motion. The matter would not be a very serious one either in time or expense and would certainly serve to cast light upon a subject which, at the present time, is shrouded in darkness.

MALLEABLE IRON FOR WEARING SURFACES.

The use of malleable iron for wearing surfaces has been somewhat limited, but a general answer to the question, "is it advisable to use malleable iron for wearing surfaces," would be, No. Owing to the softness of the metal, the abrasion is very marked and harder iron has longer life. This can readily be seen in passenger car journal boxes where after a few months' service holes are worn through the sides of the boxes, and such surfaces are now protected by steel wearing strips. For parts subjected to a lesser degree of motion, such as center plates, side bearings or draft gear, the malleable iron will prove satisfactory if properly designed, care being taken to so proportion the wearing surfaces as to keep the load per unit of surface and the friction within safe limits. While malleable iron may furnish a fairly satisfactory wearing surface under favorable conditions, the general tendency is to restrict its use to purposes for which, as a substitute for cast-iron, its greater strength makes it particularly valuable.—*T. A. Foque, topical discussion before M. C. B. Association.*

AUTOMATIC MACHINERY FOR RAILROAD SHOPS.—The question of automatic machinery is one that should receive a great deal of thought. Duplicate work can be turned out economically by its use, and a railroad company can save considerable money by standardizing studs, bolts, pins and a hundred other things, making them at the principal shop with automatic machinery and distributing them over the whole road.—*Mr. H. T. Bentley, Western Railway Club.*

RAIL FAILURES.—The results of our investigations indicate that the greater part of the difficulty which occurs to-day with rails under heavy traffic is due to unsound condition of the steel, a condition which existed in comparatively slight degree in the earlier rails.—*Robert Job, American Society for Testing Materials.*

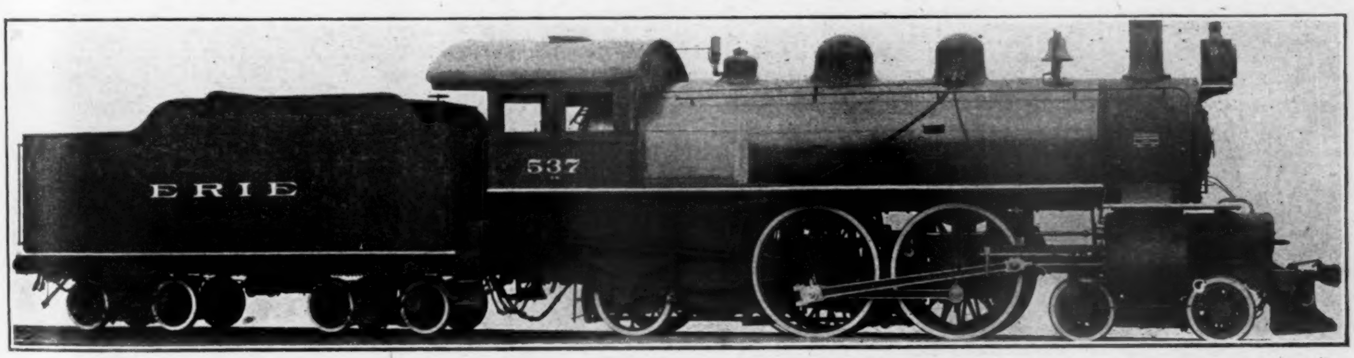
COLE BALANCED COMPOUND.

ERIE RAILROAD.

The excellent results obtained from the Cole balanced compound on the Pennsylvania Railroad testing plant at the St. Louis Exposition and its successful service on the New York Central justify expectations of equally satisfactory results under the difficult conditions on the Erie Railroad which have been outlined in this journal. The accompanying engraving illustrates a 4—4—2 type locomotive built by the American Locomotive Company, at Schenectady, upon the Cole balanced compound system. Comparisons with the earlier Cole compound may be made by referring to our June number, 1904. The leading dimensions of the Erie locomotive are given in the following table:

ATLANTIC TYPE COLE BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	23,860 lbs.
Weight in working order	206,000 lbs.
Weight on drivers	115,000 lbs.
Weight of engine and tender in working order	368,800 lbs.
Wheel base, driving	7 ft.
Wheel base, total	28 ft. 9 ins.
Wheel base, engine and tender	60 ft. 9 ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.82
Tractive effort x diam. drivers ÷ heating surface	513
Heating surface ÷ grate area	64.3
Total weight ÷ tractive effort	8.63
CYLINDERS.	
Kind	Compound.
Diameter and stroke	15½ and 26 by 26 ins.
Piston rod, diameter	3 ins.
VALVES.	
Kind	14-in. Piston.
Greatest travel	6 ins.
Steam lap	1 in.
Setting, ¼ in. lead forward motion when cutting off at 11 ins. of the stroke.	
WHEELS.	
Driving, diameter over tires	78 ins.
Driving, thickness of tires	3 ins.
Driving journals, diameter and length	10 by 12 ins.
Engine truck wheels, diameter	36 ins.
Engine truck, journals	6½ by 12 ins.
Trailing truck wheels, diameter	50 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Extended wagon top.
Working pressure	220 lbs.
Outside diameter of first ring	70¾ ins.
Firebox, length and width	108 1-16 by 75¼ ins.
Firebox plates, thickness	⅜ and 9-16 ins.
Firebox, water space	front, 4 ins; sides and back, 3½ ins.
Tubes, number and outside diameter	388 2-in.
Tubes, gauge and length	11, 17 ft. long.
Heating surface, tubes	3,433.55 sq. ft.
Heating surface, firebox	188.47 sq. ft.
Heating surface, total	3,622.02 sq. ft.
Grate area	56.3 sq. ft.
Exhaust pipe	Single
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 2¼ ins.
Centre of boiler above rail	111⅝ ins.
TENDER.	
Tank	Water bottom.
Frame	12-in. channels and plates.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,500 gals.
Coal capacity	16 tons.



COLE BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD.

G. W. WILDIN, *Mechanical Superintendent.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

IV.

(For previous articles see pages 154, 200 and 250.)

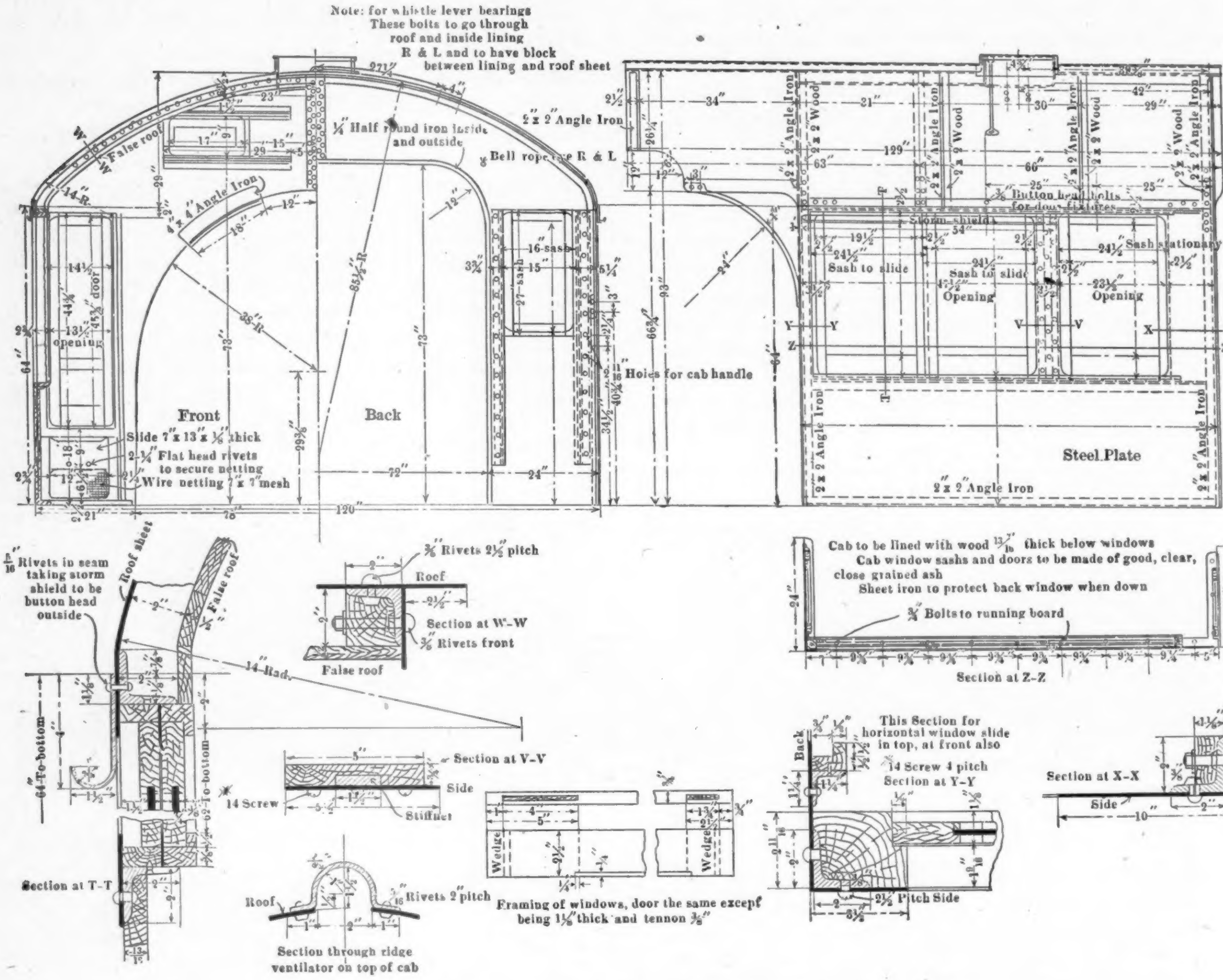
CABS.—The cabs of all four of the standard types are of the same general design, all being of metal with wooden roofs, the frames being of 2-in. angles, the sheets being of 7-lb. steel. The only essential variations are confined to the fitting of the cabs to the different boilers. All of the cabs are 120 ins. wide, and all are 90 ins. long under the windows.

BILL OF STEEL.

4 pieces 60½ x 93 No. 8 steel for front and back.
2 pieces 64½ x 90½ 7-lb. steel for sides.
2 pieces 63½ x 70 7-lb. steel for front of roof.
2 pieces 66½ x 70 7-lb. steel for back of roof.
The angles for the frame throughout are 2 x 2 in.

All of the cabs are braced to the back heads of the boilers by means of two diagonal rods 1 in. in diameter. They are secured to the boilers by means of 4 x 4-in. angles, 18 ins. long.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD CAB FOR PASSENGER LOCOMOTIVES—HARRIMAN LINES.

The designs are sufficiently alike to permit of illustrating the construction with one drawing, which is that adapted to the passenger locomotives which are of the Atlantic and Pacific types. These cabs have ridge ventilation in addition to the trap ventilator through the roof. The windows are large, the side windows having three sashes, of which the forward one is stationary while the others slide. The cabs all have 9 x 17-in. slide windows in front over the boiler. The glazed doors opening on to the running board are 13½ x 44¾ ins., each having a 6½ x 12-in. wire netting opening, covered with a slide of steel plate. The rear windows of the cabs are 16 x 26 ins. over the sash. The details shown in the drawing, together with the section through the roof, show the construction of the frame and the attachment of the wooden portion. It will be noticed that a space of 2 ins. is provided between the ½-in. false roof of wood and the outer steel roof. The cabs have 3-16-in. wooden lining below the windows. The bill of steel for the cabs of the Atlantic and Pacific types shown in the engraving is as follows:

TROUBLES OF LONG AGO.—In the old days during zero weather we would frequently have a number of rails broken in a single night. I recollect we had 255 rails broken in one night between Cincinnati and Cleveland, when the thermometer made a drop from 40 deg. above to 10 deg. below zero in fifteen or eighteen hours. We have seen the wonderful advance made since the introduction of steel rails and steel-tired car wheels. In the old days it was not anything unusual to find a broken car wheel in a train when the thermometer dropped suddenly; and the old pumps on the side of the boiler would sometimes freeze up and the whole road would be tied up over night. All that has been overcome, and we never hear of anything of the kind. It seems marvelous what was accomplished in those days of train despatching and the movement of trains by telegraph with so many difficulties to overcome. Some of the younger generation of railroad men can scarcely realize the trials and tribulations of railroading thirty years ago.—*Mr. C. S. Rhoads, before New York Railroad Club.*

DOES EDUCATION OF FIREMEN PAY?

By B. P. Flory,
Mechanical Engineer, C. R. R. of N. J.

There has been considerable discussion in the technical press lately as to whether it pays to educate firemen, and, in fact, the other employes of the company, as hostlers, shop apprentices, etc., on whom the road has to (or should) depend for the making of engineers and firemen.

While the general tendency seems to be in favor of some scheme of education, yet a number of the railroads have not yet decided in their minds exactly what the benefit will be to their individual systems.

The writer last summer had occasion to make some coal and water tests, and thought that the results might prove interesting to the railroad world at the present time.

The engine selected was an Atlantic type, cylinders 19 x 26 ins., with American balance slide valves; working pressure, 200 lbs.; weight on drivers, 100,220 lbs.; diameter of drivers, 84¼ ins.

The runs were made between Jersey City and Philadelphia, with four cars on most of the trains, the distance being 180.8 miles for the round trip.

When starting the test the engineman and the fireman were instructed to run and fire the engine in their usual manner.

The first tests the fireman had a heavy fire, and kept the engine blowing off a great part of the time.

The record of the first test is as follows:

Date.	Weight Train (Tons.)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal (lbs.)	Water, (lbs.)	Coal, Per Ton Mile.	Water Per Ton Mile.
1904.								
July 27	162.13	46.41	192	4-7-00	11,409	78,461	.390	2.67
July 28	171.58	45.63	201	4-9-05	11,224	76,808	.352	2.47
July 30	190.7	46.09	194	4-8-30	11,956	77,910	.318	2.13

After the above tests were completed, we got at this fireman and gave him instructions how to fire, using a light fire in starting and firing light all the way. That this made an appreciable difference is shown by the following tests:

Date.	Weight Train (Tons.)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal, (lbs.)	Water, (lbs.)	Coal Per Ton Mile.	Water Per Ton Mile.
1904.								
Aug. 29	170.0	45.24	193	4-13-25	7,952	72,398	.259	2.38
Aug. 31	174.6	47.43	188	4- 1-45	9,385	72,398	.297	2.29
Sept. 2	170.5	46.8	189	4- 3-50	8,319	71,295	.270	2.32

It will be noted that the coal consumption went down from an average of 11,530 lbs. per round trip, or .353 lbs. per ton-mile, to an average of 8,552 lbs. per round trip, or .275 lbs. per ton mile, a saving of 22.1 per cent.

On the second trip of this latter series of tests the fire had not been properly cleaned by the hostler before leaving, and it was necessary to do this at Philadelphia, which was not done on other runs.

This fireman was counted as a good fireman for keeping up steam, but he evidently did not try to save coal.

That he had kept up his record made in the second series of tests is shown by a third series of tests which were conducted lately. The results are as follows:

Date.	Weight Train (Tons)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal, (lbs.)	Water, (lbs.)	Coal Per Ton Mile.	Water Per Ton Mile.
1905.								
Apr. 24	170.7	46.47	182	4- 6-00	9,561	73,316	.313	2.37
Apr. 25	168.6	47.33	181	4-15-00	8,265	72,765	.271	2.38
Apr. 26	179.5	46.74	183	4- 4-30	7,679	72,397	.236	2.23

The weather during these last tests was colder than the second series, and more variable, which accounts for different consumptions of coal on the various days. Even with this against the test, the average coal consumption per round trip was 8,501 lbs., or .273 lbs. coal per ton mile, which is slightly less than on the second series of tests.

These tests and the results obtained have done the company a great deal of good, in that they have stimulated other firemen to try to equal this record. I do not think that this is an individual case, and it is safe to presume that the same conditions will be found on other roads, especially on those using anthracite coal. A saving of 2,500 lbs. coal per day, or of even 1,000 lbs. of coal a day per engine, means something to a company when one remembers how large a per cent. coal forms of the operating expenses of a road.

NECESSITY FOR GREATER BRAKING POWER IN FREIGHT SERVICE.

An important opinion on the need for greater braking power on freight cars was expressed before the Master Car Builder's Association by Mr. F. M. Gilbert, mechanical engineer of the New York Central Railroad.

A proper consideration of acceleration and velocity, the prevailing higher speeds and heavier trains and the necessity for faster schedules, suggest that it is time that we look at the question of retardation and devote some time and thought to the question of how to absorb the energy of our high-speed heavy freight trains in less time than is now possible with the braking power we are using. In view of the existing conditions the writer cannot see that any arguments are required to show that we do need greater braking power on freight cars.

From the crude state of the air brake apparatus it is useless to describe the ideal conditions—where the braked power should automatically change with the loads carried by the car. So far as the writer's knowledge goes, no apparatus has as yet been developed that will accomplish this satisfactorily. We must therefore confine ourselves to getting the highest safe percentage of the light weight of the vehicle.

The matter then resolves itself into the questions:

1. Can we provide greater braking power on freight cars without introducing complications that would be detrimental to the equipment?

2. If we can provide this increased braking power without detrimental effect upon the equipment, how can it best be done cheaply and with the fewest complications?

The general practive to-day is to brake freight cars to 70 per cent. of their light weight. This 70 per cent. when corrected for the cylinder effect absorbed by the brake gear will be reduced practically 20 per cent. We therefore arrive at the point of application of brake shoes with 80 per cent. of 70 per cent. of the light weight of the car, which is 56 per cent. of the light weight of the car.

If we assume for 100,000-lb capacity cars a light weight of 38,000 lbs., we have 56 per cent. of 38,000, which equals 21,280 lbs. If we add to the light weight of the car its capacity, plus the 10 per cent. permissible overload, we have 38,000 plus 100,000 plus 10,000, which equals 148,000 lbs., and the per cent. of total weight braked is 21,280 multiplied by 100 and divided by 148,000, which equals 14.37 per cent. This braking power on a straight, level road does its work fairly well, but it is not sufficient on grades and curves, where the distance in which stops must be made is shorter.

The writer is of the opinion that freight cars can be figured to be braked at 100 per cent. of their light weight without injurious results to the equipment; this when corrected for the power absorbed by the brake gear will reduce the actual braked weight to about 80 per cent. of the light weight of the car.

The three principal factors associated with the air brake that are productive of injury to the equipment are:

1. Lack of simultaneous application and release of the brakes on the various vehicles constituting the train.

2. Lack of equal percentage of braked weight on the various vehicles constituting the train.

3. Lack of maintenance in proper repair of the air brake mechanism of the various vehicles constituting the train.

None of these factors will be affected one way or the other by the recommended increase in brake power, except the question of repairs, which will require more attention.

The benefits to be realized from the higher braking power are:

The ability to stop trains in a shorter distance; hence the ability to approach yard limits, meeting points, etc., at a higher velocity, thus enabling faster time to be made over the respective divisions.

Owing to the large number of freight cars on which the levers are proportioned for 70 per cent. at 50 lbs. equalized cylinder pressure, I am of the opinion that the proper way to get the increased braking power is by raising train-line pressure the proper amount.

Our air brake friends will probably say that triple valves designed for 70 lbs. train-line pressure will not work satisfactorily with higher pressures; they will also probably say that the increased leakage from train pipes under the higher pressure will overtax the pump. The answer to these objections it appears to me to be that the triple valves should be modified so as to work satisfactorily and the train pipe should be kept tight. As the matter now stands we are not securing the results from air brake apparatus that we should.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

A German locomotive building shop offers a good opportunity to see aristocracy and servility. If you go about with a high official you will see the caps of all the foremen and workmen come off in deference to the officer. The poor German workman (he is skilful and faithful, but poor) gets perhaps 3 marks per day if he is an all-around mechanic. A rod fitter gets perhaps 80 marks per month (about $20), depending on the location. In these shops labor in building locomotives amounts to about one-third and material two-thirds of the total cost of building. The workmen begin at 6 a. m. They breakfast at 8 a. m., return to work at 8:20, stop for dinner at 12 noon, and work from 1 to 4 p. m. It is not a desirable arrangement. I found in France in one of the shops visited that labor and material were about equal in cost.

Milling machine practice is making rapid progress in Europe. In the most up-to-date plants planers are almost entirely going out of use. At the works of Messrs. Neilson Reid & Co., Glasgow, the frames of the new Canadian Pacific locomotives then just completed were not planed, but milled. Two frames were placed on the machine so as to take up the least space in width, and were finished at the same cutting. The cutter was built up. It is said to be 14 ins. in diameter and at least 5 ft. long. The writer did not see it, but was told by one who had seen it. At Borsig's works in Tegel all locomotive frame and rod work is done by milling machines. Six plate frames for German locomotives are secured to the machine table, which is as large as one of our big frame slotters, and the work which we do by slotting heads is there done by milling, and is done quickly. Engine truck boxes are set up in rows of 12, and are finished in two cuts by special milling cutters, which are made to suit the standard boxes of the Prussian State Railways. In England and on the Continent the drafting room renders the greatest kind of help to the shop by providing uniformity in parts of a large number of engines, making it possible and profitable to fit up special cutters for such work as this. A trip through the leading European workshops would be very profitable if this subject alone was taken up. At Tegel excellent use is made of high-speed steel, especially one of the brands which is well known at home. Milling cutters made of it are doing heroic service there, and are used for every conceivable purpose.

These notes are necessarily of a rambling character and are not as thorough as they should be. On the surface there appears to be comparatively little in European practice which we may profitably adopt. But it pays to dig beneath the surface. The Borsig works have frequent orders for the Prussian State Railways. By the way, the workmanship is beautiful. Valves and valve-seats are scraped, and all that. It is far too fine. In going through the Borsig storehouse a lot of new parts for the standard engines will be found. These are very carefully designed and equally carefully adopted. Then they remain standard for years, as there is little opportunity to improve upon them. Therefore, when not busy on contracts, the works may make a few of these parts for stock, knowing that they will be needed, thus getting the manufacturing advantage from the strict standards. This surely has its good points, and exactly the same thing is done by all the English railroads, where the matter of duplication of standard parts is carried out most extensively and in an admirable way.

Returning for another word about milling—it is easy to make and profitable to use patterns for profile milling in case three or four standard locomotives use the same main rods and if from 60 to 70 new engines are built every year for replacements. On several English roads the valve gear work is so designed and so carefully made as to render it possible to take the valve motion from one engine and put it under another one—and it fits. This is occasionally done in order to get engines out of the shops quickly. The holes for the pins of valve motions are usually lapped out, and so also are the slots in the links. These are fitted perfectly on the machines, so that the link block will drop easily from one end to the other of the link, and no hand fitting is required, the fit being an absolutely perfect piece of work. A great deal of case hardening is done, especially in England, and the work is usually put up with the oxidized surfaces left as they come from the boxes.

In three shops in England and in two on the Continent the writer was asked to collect and present in the columns of this journal the most up-to-date information upon milling. It appears that a milling wave is passing over Europe. In several places home-made milling machines—converted from planers—were seen, and were doing good work. Large, solid cutters are the rule for wrought iron and steel, while larger cutters with inserted teeth are in common use for cast iron. At the Borsig works a test outfit for milling cast iron has proved very profitable. A special motor drives a large new milling machine, and a good man is constantly employed in making tests of cutters of various kinds upon broad surfaces of cast iron and steel. By weighing the work and reading the ammeter the power required per unit weight of metal removed is studied, and my courteous conductor, the works manager—who does not speak a word of English—made me understand that this experimental work had greatly increased the rate of cutting and reduced the cost of milling. This, by the way, is an admirable demonstration of the convenience of electrical measurements in introducing improved methods in the shops.

No twist drills are bought for the Borsig works. They are all made in the tool room, which is the largest I ever saw, and is chiefly engaged in making milling cutters. A fine, large twist drill was exhibited. It was 3½ ins. in diameter and about 4 ft. long. The tempering of milling cutters was watched with interest. Gas furnaces are used, and the cutters are heated very slowly. Until red hot they are not put into the furnace at all, but are heated by radiant heat by being placed on a plate under the furnace, the gas burner of which heats cutters to a high temperature in the furnace while it heats to a red temperature those which are to go into the furnace. This is said to be the secret of hardening good cutters.

Small pieces of high-speed steel were in some mysterious way stuck on the ends of large lathe and planer tools. The joints were fused and resembled brazing, but they hold heavy cuts. I did not succeed in impressing the works manager with the desirability of telling me how it was done or letting me see the process.

G. M. B.

(To be concluded.)

PRODUCTION IMPROVEMENTS.

REAMER FOR CONNECTING ROD KNUCKLE JOINTS.

Fig. 1 illustrates a very handy reamer used in the roundhouses of the Lake Shore & Michigan Southern Railway for reaming the knuckle pin holes in connecting rods without removing the rods from the engine and thus saving a large proportion of the time ordinarily required for this operation. The cutters are made right and left spiral and ball bearings are used between the stationary and revolving parts in order to reduce the power required for its operation to a minimum. A ratchet wrench is used on the square. We are indebted for this information to Mr. S. K. Dickerson, master mechanic at Collinwood, Ohio.

LOCOMOTIVE BLOCKING JACK.

The blocking jack illustrated in Fig. 2 is in use at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad. A pair of these jacks are furnished for each pit in the erecting shop and when the wheels are removed from a locomotive one of these jacks is placed underneath the frames at the center of the cylinders while the other one is placed underneath the frames at about the middle of the firebox. These jacks are very much more satisfactory than blocking as they can very readily be adjusted to any desired height; they take up a comparatively small amount of room and do not in any way interfere with the work on the engine, and last, but not least, no time is lost in hunting up blocking. The jacks are quite heavy and four rollers are provided so that they can easily be moved about. We are indebted to Mr. D. J. Redding, master mechanic at McKees Rocks, for this information.

DEVELOPMENT OF SHOPMEN.—When you have reached the limit of the high-speed steel and heavy built shop tools, what are you going to do with your men? You still have room for increasing the output if you develop them as you should, especially their loyalty.—*Mr. W. White, Western Railway Club.*

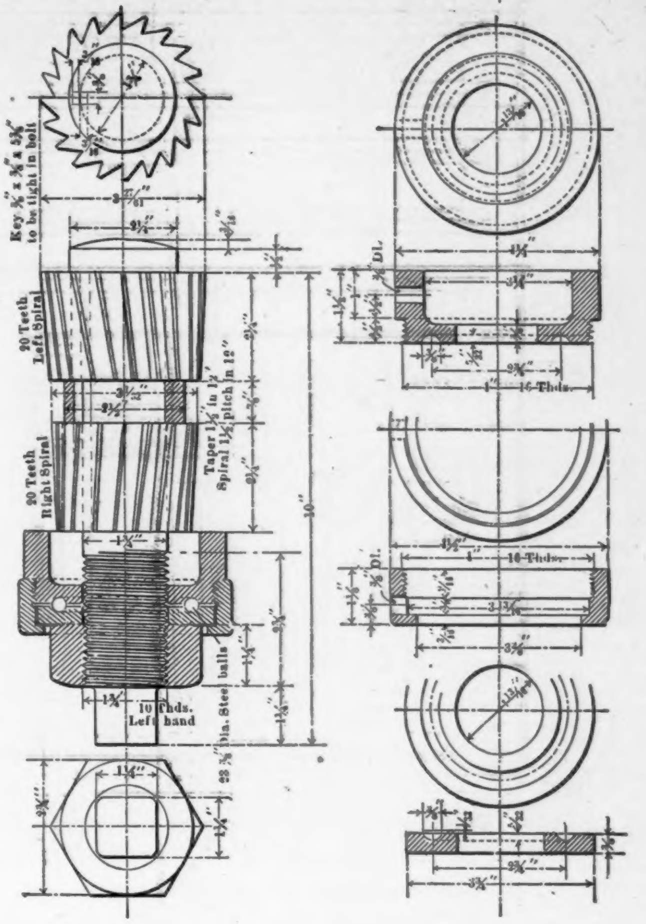


FIG. 1—REAMER FOR CONNECTING ROD KNUCKLE JOINTS.

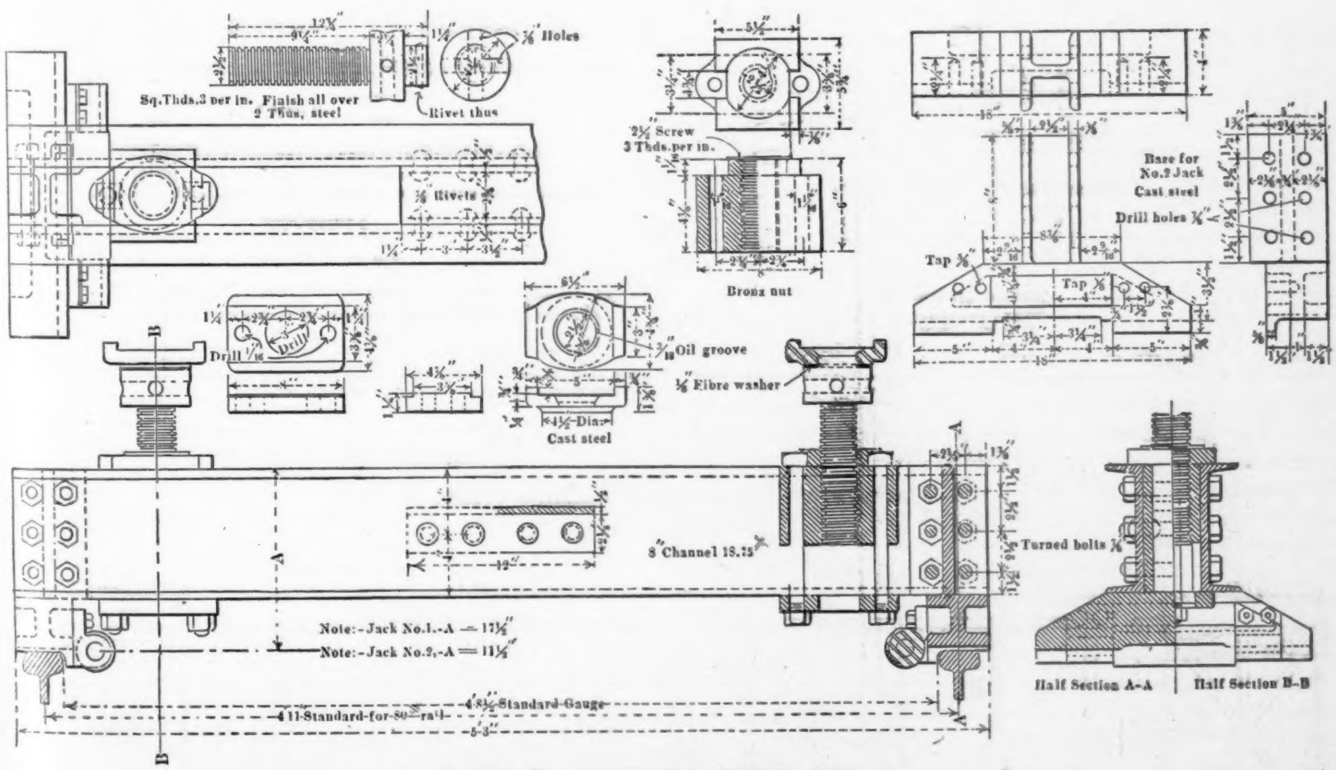
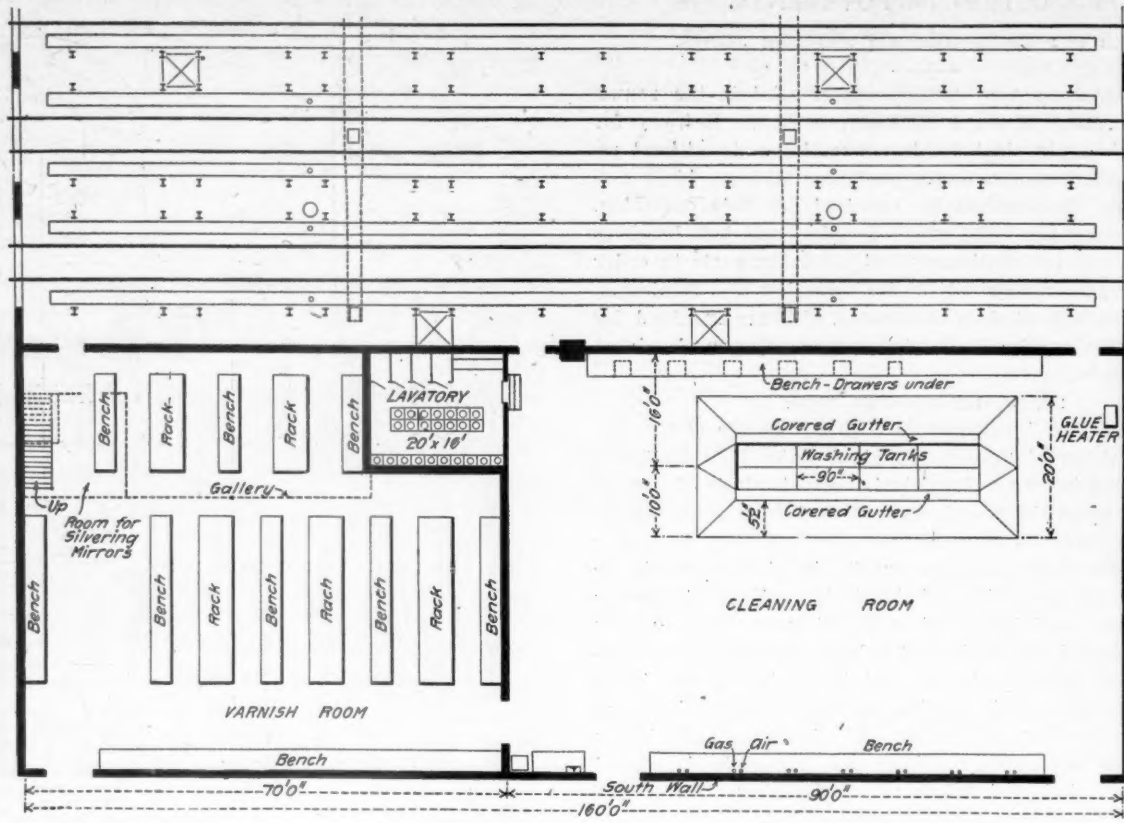


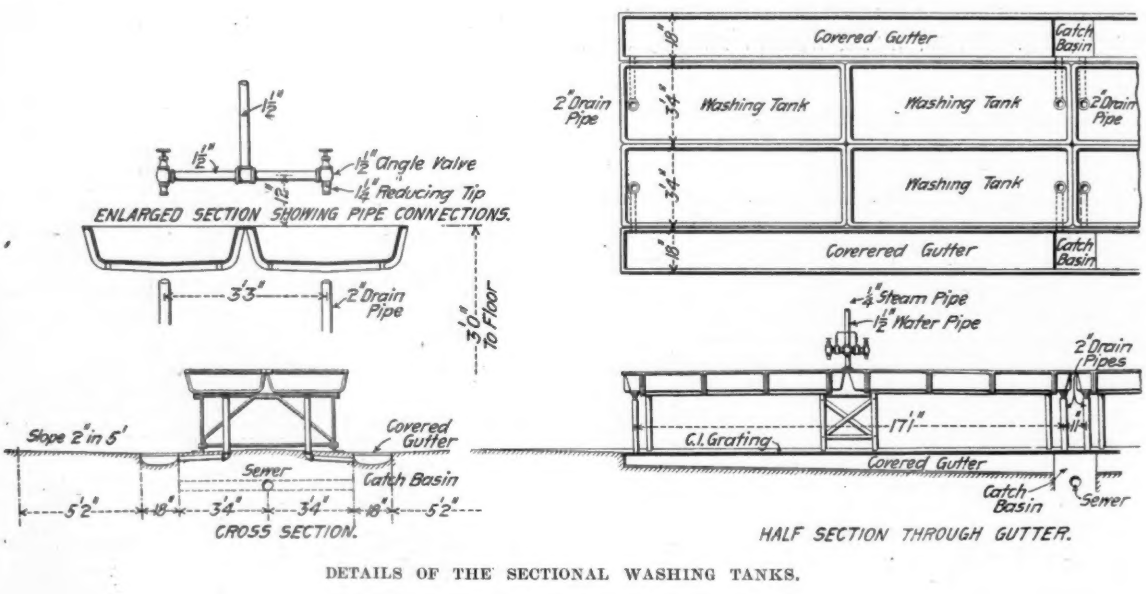
FIG. 2—LOCOMOTIVE BLOCKING JACK.

CARE OF BELTS.—We have our own belt room, keeping a record of every belt failure as well as the life history of every belt installed—paying the highest price for belts, yet having them cost less for operation and renewal, with fewer breakdowns, than I believe in any machine shop of similar size in the world.—*Mr. Harrington Emerson, Western Railway Club.*

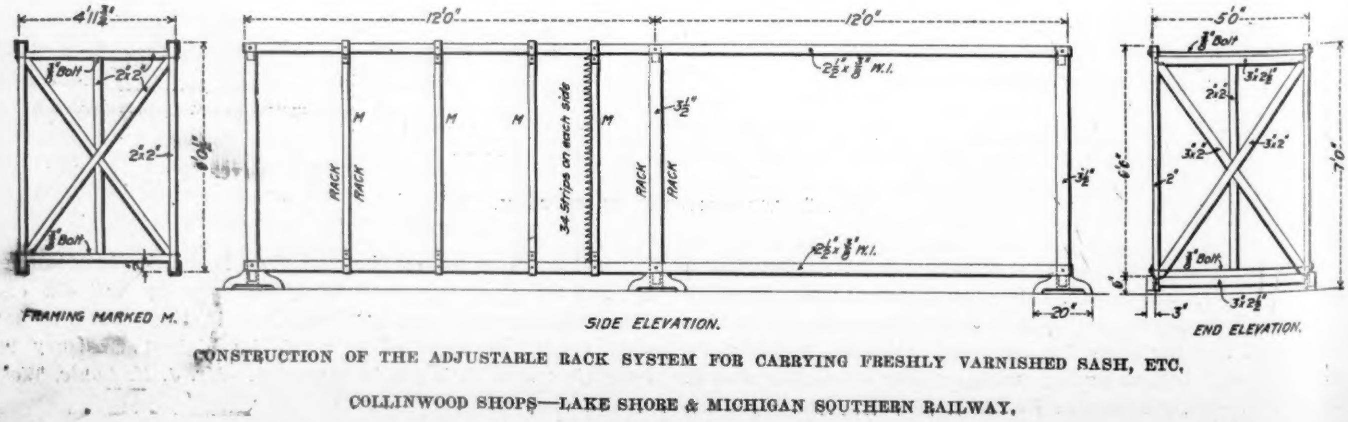
IMPORTANCE OF JIGS.—The new shop is usually handicapped by lack of jigs, templates, etc., possessed by the old one. These things will remedy themselves in time, but the new shop cannot be expected to reach its highest efficiency for some time after it is put in operation.—*Mr. J. H. Lonie, Western Railway Club.*



DETAIL PLAN OF SOUTH END OF THE PASSENGER CAR PAINT SHOP, SHOWING ARRANGEMENT OF CLEANING AND VARNISHING ROOMS.

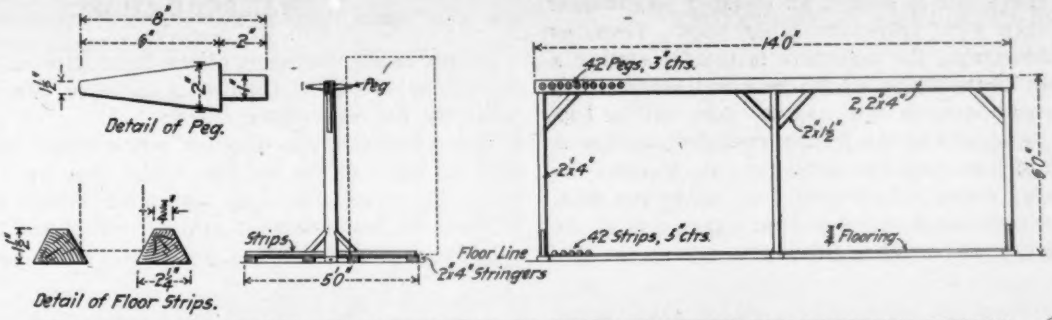


DETAILS OF THE SECTIONAL WASHING TANKS.

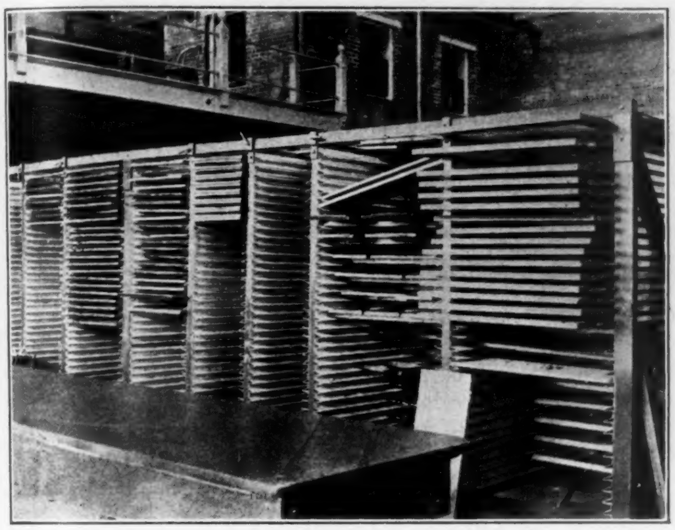


CONSTRUCTION OF THE ADJUSTABLE RACK SYSTEM FOR CARRYING FRESHLY VARNISHED SASH, ETC.

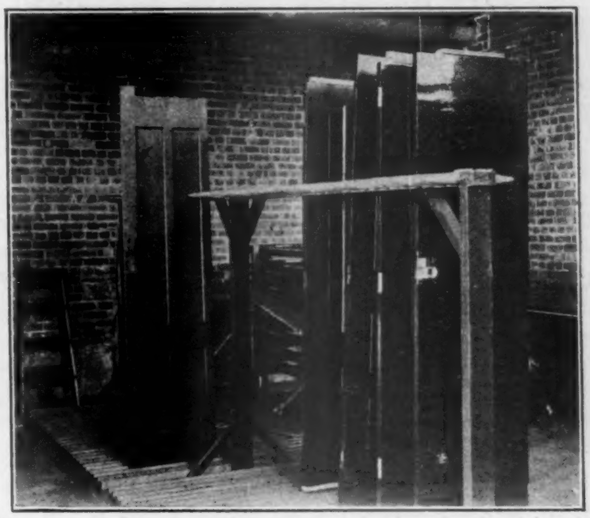
COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



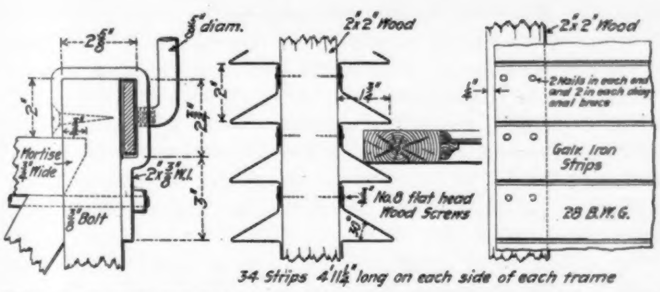
DETAILS OF ARRANGEMENT AND CONSTRUCTION OF THE RACK SYSTEM FOR SUPPORTING FRESHLY VARNISHED DOORS.



ADJUSTABLE SYSTEM OF RACKS FOR STORING FRESHLY VARNISHED SASH AND BLINDS.



STANDING RACKS FOR STORING FRESHLY VARNISHED DOORS.



DETAILS OF THE SPECIAL CORNER-PIECE CLAMPS FOR SECURING THE STANCHIONS AND OF TRIANGULAR GALVANIZED IRON SUPPORTING STRIPS.

PASSENGER CAR PAINT SHOP VARNISH AND CLEANING ROOMS.

The varnish and cleaning rooms of the passenger car paint shop at the Collinwood shops of the Lake Shore & Michigan Southern Railway are especially well arranged. In the cleaning room, which adjoins the main shop on the south end, is to be found a novel system of washing tanks, which is used in the washing of sash and other parts of the woodwork of passenger cars under repairs. The question of supplying sufficient tank room for this work on so large a scale and in such a manner that it shall be easily accessible, has been very successfully met by the system shown in the accompanying engraving. An interesting design of sectional tanks or tubs has been originated which provides not only simplicity of construction, but also ease of repairs when same is necessary.

There are eight of these washing tanks or tubs, each of which is built up of sections, as shown. Each tank consists of three middle sections and the necessary two end pieces, all of cast-iron, which are bolted together, making a complete tub of great strength and durability. This method of erecting them effected a very material saving in the pattern work for the castings, and if by chance any tub is broken, a new section may be bolted in place of the broken one with comparative ease. The method of erecting them, as well as of supporting them upon the iron framework stands, is well shown in the drawings.

In front of each row of washing tanks is located a covered gutter for draining the drip from washed pieces to the sewer. The floor slopes toward this gutter for more than 5 ft. back from it. Each tub is piped up for water supply and also with a steam connection for delivering heated water; this is accomplished by injecting the steam, from the ¼-in. pipe, as shown, into the water pipe, while the cold water is running from the tap, the steam being led into the water pipe through a special mixing connection in a tee fitting.

Another feature which is of interest is the system of racks used in the varnish room for storing window sash and blinds while drying. This arrangement of racks provides a most efficient means for storing the entire equipment of a car while drying, so that the least possible amount of room is required. It consists of a long framework of iron bars, as shown in the accompanying engraving, with adjustable stanchions, which may be arranged to accommodate any width of sash or blinds. The stanchions, or movable partitions, are merely slid along the iron bar guides, and when properly spaced, are clamped securely by a binder at each corner.

The plan of the varnish room indicates the locations of these racks, of which there are three, each 24 ft. long and 5 ft. wide. The peculiar shape of the supporting strips is such as to carry a sash by contact at a corner only, so that the freshly varnished surface is not interfered with. When the sizes of sash change the stanchions are adjusted to the particular position which will accommodate them and are clamped there by the special corner piece clamp. These racks are each located between the varnishing benches, so that the work may be placed directly in the drying rack after varnishing.

For the support of freshly varnished doors a different system of racks is made use of, as shown in the additional photograph and detail sketch. This is a standing rack, consisting of a floor frame piece with strips running crosswise, having

beveled edges; above this is erected an elevated longitudinal supporting stringer with projecting taper pegs. Then, as shown in the photograph, the procedure is that of resting a door between two of the strips on the base and between two corresponding pegs above; in this way the door will be supported entirely by edges and the freshly varnished surface is protected. Each of these two door racks is 14 ft. long and the elevated supporting stringer is located 6 ft. above the floor. Each rack has a capacity of 54 doors upon either side of the stringer, making the total capacity 108 doors.

RAILROAD SHOPS.

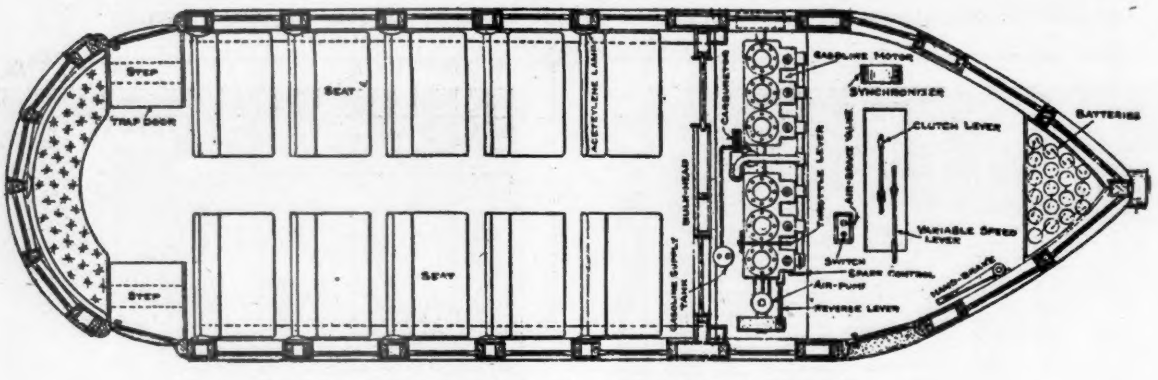
In discussing the report of the Committee on Shop Layouts before the Master Mechanics' Association, Mr. F. F. Gaines made the following observations:

The report seems to question very strongly the advisability of large shops or the use of a single shop for a railroad system. The large shop is no innovation whatever. The Pennsylvania Railroad shop at Altoona, which has been in existence for a great number of years, is a fair example of large shops. The present output of our Reading shops, where all the heavy repair work for the road is done, has been brought up in the past year to an average of three engines per day, and will be a little over 800 engines for the year, an increase of 22 per cent. over the previous year, and this has been done with a notoriously old tool equipment, and only a sufficient number of tools to operate 48 out of 68 pits; in other words, the erecting shops, which are in two bays, have been divided into 12 pits to each corner, which are being operated, and the remaining pits used for storage purposes on account of lack of sufficient machinery to run them. On the basis of 48 pits we are getting about an engine and a half per pit per month.

Referring to the articles from the AMERICAN ENGINEER (by Mr. R. H. Soule), which are published as an appendix to the committee's report, there is considerable exception to be taken to them. Tables of outputs, as given, are valueless unless considerably more is known about the conditions under which the output is made.

The character of traffic, grade, ballast, curvature, water supply, weight of engine, etc., vary for each locality. For instance, on a recent trip of inspection by some prominent officials, a certain shop located in a territory with a good water supply was very highly commended for its output on the unit basis. The average cost of engines repaired, however, was only from $300 to $350 per engine, or about one-fourth cost per engine at our Reading shops. During the past year the average cost of engines receiving general repairs was slightly under $1,500. This may seem high, but the power had become run down considerably, and the majority of engines required heavy boiler work, so that while apparently high it is really a reasonably low figure, it being about the same as that for the Central Railroad of New Jersey, as the average cost per engine varies only a few dollars from the average cost per engine on the latter road. This shows the fallacy of comparing output of shops in different localities on the unit basis.

The proper proportion of floor area for each department, based on the number of stalls, is also worthless when simply tabulated without reference to conditions. A majority of the shop layouts are deficient in floor area for machine tools and boiler work. The newer heavier power requires much more machinery to obtain the same output as was previously accomplished when engines were small. Higher steam pressures have very noticeably decreased the life of flues and fireboxes, and many recently built shops are preparing to overcome this defect by extensions. As being of interest in this connection I have tabulated the present area and the area that will exist



PLAN OF GASOLINE MOTOR CAR—UNION PACIFIC RAILWAY.

GASOLINE MOTOR CAR.

UNION PACIFIC RAILWAY.

A light motor car designed and built under the direction of Mr. W. R. McKeen, superintendent motive power of the Union Pacific Railway, has been in service on that road since April 1 of this year. It has met expectations to such an extent as to lead to the decision to build six more of a larger capacity. The experimental car is now in regular service at Portland, Oregon.

This car is 31 ft. long and seats 25 passengers. It is mounted on a four-wheel specially designed truck, and weighs a little over 20 tons. The accompanying floor plan shows the shape of the car and the interior arrangements. A six-cylinder 100 h.-p. engine drives the forward axle by means of a mechanical chain drive with several gear speeds, the speed of the engine itself being variable through a wide range. A "synchronizer" facilitates the speed changes. A reverse throttle spark lever and emergency spark cut out and air brake valve are all arranged conveniently for the operator. Six cells of battery supply current for a "make and break" spark device.

This car is designed for service on grades as steep as 4 per cent. and for frequent stops, its maximum speed being about 35 miles per hour, but by changing the gear ratios it may be run at 60 miles per hour. Compressed air is used in starting, and the acceleration is remarkably rapid. For the first 50 ft. the acceleration is slower than that of an ordinary electric car, but from 100 ft. it is very rapid. On a level or grade of 25 ft. per mile the car will start on the high speed direct connected, without the use of gears. One operator handles the car easily. It will run in either direction. The vibration and noise of the engine are not noticeable when running, and the car is reported to be entirely satisfactory.

It has been running experimentally and in regular service since last April, and ran with its own power from Laramie to Salt Lake City early in May, making the 2,095 miles with entire satisfaction. Since it first started the car has not been out of commission and has not required more than slight running repairs. It has hauled a standard mail car of 52,100 lbs. up a 1.6 per cent. grade at the rate of 11 miles per hour. It has also been tried on a 7.8 per cent. grade (a coal shute trestle), where it was stopped and started repeatedly.

when the present extensions, which are now under way, are completed at our Reading shops:

Shop.	Original area. Square feet.	Additional area. Square feet.	Total area Square feet.	Area per pit as revised.
Erecting, 68 pits, two bays, 740 x 70	103,600	......	103,600	1,523.5
Machine, one bay, 740 x 60	44,400	Extension, 400 x 250 100,000	144,400	2,123.5
Boiler, two bays, 400 x 120	48,000	Extension, 220 x 170 400 x 50 57,400	105,400	1,550.0

In a great many cases the blacksmith shop is used for both car and locomotive forgings. The use of steel castings for many locomotive parts, instead of forgings, and the manufacturing of other parts on turret lathes and special machines for bar stock, has greatly reduced the necessary output of this department, so that while the Reading shop, having an area of 37,360 sq. ft., or 525 sq. ft. per locomotive pit, is apparently small, it has been found from actual experience to be ample and with a good margin of reserve.

A sufficient number of cranes to properly handle the work should not be overlooked. In the older shops, which were not equipped with overhead cranes, each machine handling work of any size was provided with an air hoist or other lifting device for handling the material from the floor to machine and back again. In the newer shops, with the overhead crane service, the air hoist is practically eliminated, while a very small number of cranes has to do the work formerly done by a large number of air hoists or other similar contrivances. Before the advent of overhead cranes in locomotive shops a large portion of the moving and lifting was done by hand, but since the advent of cranes no one ever thinks of doing any such work, no matter how long he may have to wait for a crane. It therefore becomes doubly important to have a very large number of cranes serving each department, and it is also desirable, in addition to overhead crane service, at particular machines to install small independent hoists, either air or electric, where there is frequent need of such service.

With the installation of new cranes that are to be put in the present shops and the present extensions that are under way the Reading shops will have the following crane equipment: In each erecting bay one 120-ton, with two trolleys; one 35-ton, with two trolleys; two 10-ton, with single trolley. The main machine shop will have three 10-ton single trolley cranes. The covered storage yard will have one 10-ton single trolley and one 10-ton double trolley. The boiler shop, with two bays, will have in the main bay one 35-ton crane, with two trolleys, and one 10-ton crane, with single trolley. In the other bay three 7½-ton cranes, single trolley. In the machine shop extension the center bay has one 35-ton crane, with two trolleys, and one 10-ton single trolley. One side bay has two 7½-ton cranes, single trolley; the other side bay two 10-ton cranes, single trolley.

The cranes operating in one bay of erecting shop, center bay of machine shop extension and the main bay of boiler shop are all on the one runway, and are not absolutely confined to territory designated. Those nearest the dividing line of each shop can be used when occasion demands in the next shop.

TELEPHONE DATA.—Mr. F. P. Fish, in an address before the Beacon Society, stated that the energy required for a single incandescent burner is 5,000,000 times as great as that required to send a message to Chicago, and that the energy required to lift a weight of 13 ounces is sufficient to operate a telephone for 240,000 years. To meet all the requirements of the service 1,000,000 trees a year are required for poles, and the average cost of every class of message is 2.2 cents. Three years ago twelve telephones for every 100 of population were considered the maximum that it was possible to supply. Now the telephone people are looking ahead to a maximum of twenty for every 100 of population.

WESTINGHOUSE COMPOUND PUMP.

BY F. H. PARKE.

The new design of Westinghouse compound pump consists of three cylinders placed vertically in tandem. The two lower ones are joined by a thin center piece, constituting the air end of the pump, and these are surmounted by a center piece and steam cylinder of the regular Westinghouse type, so that in general appearance this new pump, although somewhat longer, is very similar to the regular Westinghouse pump that has been standard on locomotives for air brake systems throughout the country for so many years. The design is very compact and, since the air end only is compound, the additional features required are so similar to the old standard that the same simplicity of operation is assured. Generally speaking, the compounding of the air end is done as follows:

The two air cylinders are of the same diameter, each having a piston suitably connected to the piston rod, which is actuated by the steam piston. These two air pistons are further connected by a drum of smaller diameter than the inside diameter of the air cylinders in such a manner that the two pistons and drum form a sort of spool. The center piece between the air cylinders fits closely about the spool, and has packing rings to prevent the passage of air from one cylinder to the other past the surface of the drum. The low-pressure air is drawn into the top of the upper cylinder and the bottom of the lower cylinder, and during compression is forced through suitable valves and passages to the annular volume formed between the spool, air-cylinder walls and center piece. The final compression takes place in this annular volume, and the air is forced out through the passages and valves in the center piece to the discharge opening. It will thus be observed that in each air cylinder both high and low pressures are single acting, but that these pressures on the air piston, as a whole, are double acting. The resultant effect, therefore, on the steam piston rod is almost the same as in the simple pump, but the air cylinder surface being twice as great as in the simple pump affords twice the opportunity for radiation of heat, and for that reason the temperature of the air discharge is considerably reduced for locomotive service.

Also by thus compounding the air end a much smaller steam cylinder can be used to operate the pump, thus causing a marked economy in steam consumption.

The present design of pump consists of a steam cylinder 8 ins. in diameter by 12-in. stroke and two air cylinders 11 ins. in diameter by 12-in. stroke, while the small diameter of the spool is 8¾ ins. It is made for a capacity similar to that of the standard 11-in. pump, which has been on the market for some years, having air and steam cylinders each 11 ins. in diameter by 12-in. stroke. Consequently the compound pump has an 8-in. diameter cylinder instead of an 11-in. as with the standard, and the steam consumption is thereby reduced to about 52 per cent. of the latter through this change alone. But by compounding the air end the capacity of the pump is increased about 16 per cent. when pumping against 90 lbs. air pressure, due to the fact that the low-pressure clearance volumes at the end of a compression stroke are filled with air at only about 40 lbs. pressure, instead of 90 lbs., as in the simple pump, and in the former case this pressure reduces to the atmospheric pressure much earlier during the intake stroke than is possible with the standard pump, consequently the volume of air drawn in at each stroke is that much greater. For this reason the saving per cubic foot of air compressed is greater than that shown by the difference in steam cylinder volumes, and from tests made on the compound pump it appears that it requires only about 45 per cent. of the steam per cubic foot of free air compressed that is required for the standard 11-in. pump. This, of course, is an immense saving of itself. But since the amount of air compressed per stroke is greater, the time required for the pump to operate is thereby diminished, and the amount of

wear and cost of maintenance are correspondingly decreased.

The air valves, valve seats and valve cages are of the same pattern as those used in the 11-in. pump, while the steam valve mechanism corresponds exactly with that of the 9½-in. pump. Also the piston rings of the two air pistons are similar to the 11-in. pump and the steam piston rings correspond to the old standard 8-in. pump, many of which are still operating on railroads. The steam and air connections are also made up of standard pieces that are now in use on the other pumps, so that by the introduction of this new compound pump the amount of repair stock required outside of that already needed by railroad shops is very small indeed.

Since the working parts are all modelled after those of the existing standards, the knowledge possessed by repair men at the present time will serve them in making repairs on the new pump without any extended extra instruction. The rules already issued for operating air pumps will in nearly all cases apply to the new pump, so that its introduction, in almost every way, will cause no trouble or inconvenience to the operating departments.

Although this pump is spoken of as the "New" compound pump, it can hardly be said to be entirely so, since the Westinghouse Brake Company, in London, have built such pumps for some years, and have them in successful operation both in England and on the continent of Europe. Therefore, it is not in the nature of an experiment as far as the design and operation of the pump are concerned. The application to American railway practice is, however, new, and several railroads have already placed them in service on trial.

The greatly increased weight of cars demanding larger brake cylinders, coupled with the greatly increased length of trains, has brought about the expenditure of a much greater quantity of air and, naturally, the requirement of a larger air pump. It was this fact that brought out the 11-in. pump. With the introduction and general adoption of the high-speed brake and high-pressure control apparatus, the main reservoir pressure was increased from 90 to 120 lbs. Consequently the work of the pump was greatly increased thereby, and the consumption of steam by the air pump has been found to be a considerable factor of importance; and the introduction of an air pump designed to give the greatly increased amount of air, and at the same time require a much less amount of steam, has been made a necessity which both the railroads and the air brake company have for some time past recognized. Such a pump must combine the requirements just outlined with the simplicity of operation and maintenance

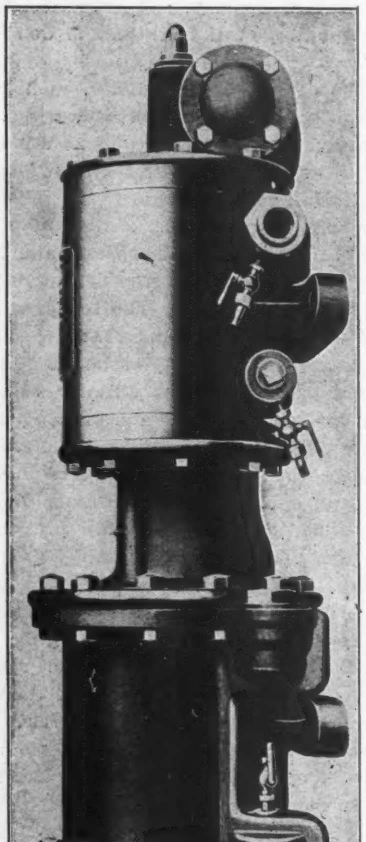


FIG. 1—WESTINGHOUSE COMPOUND PUMP.

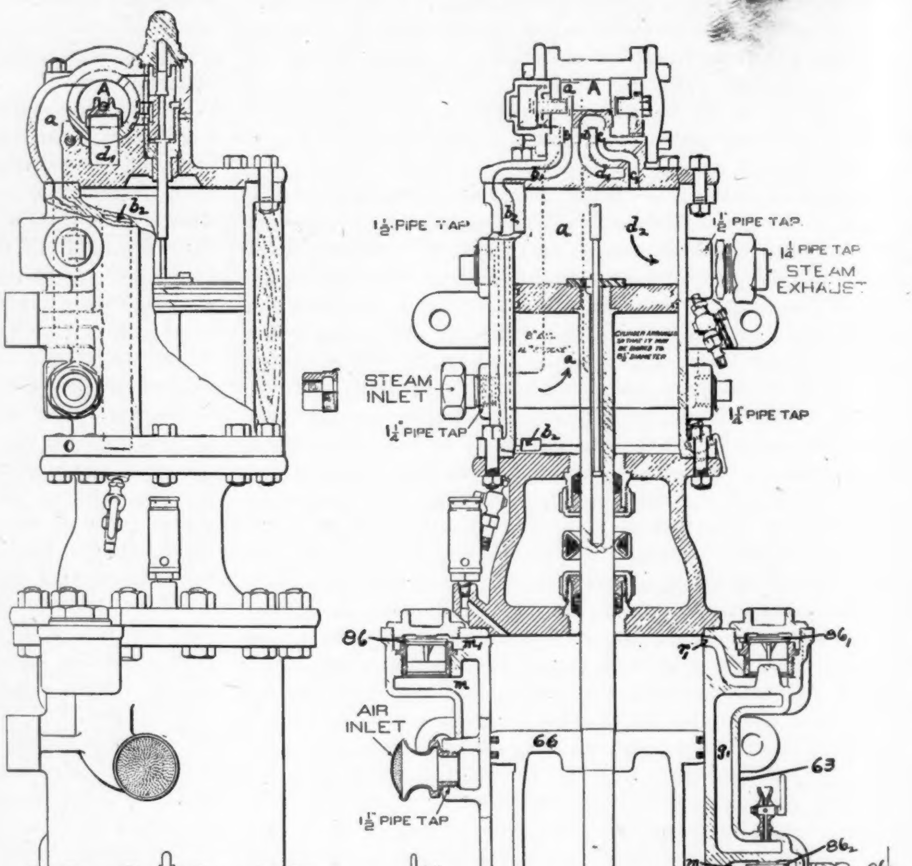


FIG. 2—SECTIONS THROUGH AIR AND STEAM CYLINDERS.

as well as the absolute reliability now had in the standard pumps. Such a pump the new Westinghouse compound pump is designed to be.

The cuts illustrating this article will give a clear idea of the design and operation of the pump for those who are interested sufficiently to follow it through. The steam cylinder is made both right and left hand, so that the steam and exhaust connections can be made on either side, or both on one side. The lower thin center piece connecting the two air cylinders contains the final discharge valves and orifice. Each air cylinder has a suction strainer through which the air is drawn into its low-pressure volume.

Figure 1 shows a side view of the pump, indicating clearly the position of the air valves and ports as well as the lugs for supporting the pump in position.

Figure 2 shows a front central section of the pump and a side view partly in outline and partly in section. From this cut the operation of the pump can easily be followed through. Steam enters from the governor at the steam inlet and passes through the port *a*, *a*, to the cavity *A* over the main valve, from thence it goes to either the top or the bottom of the steam cylinder in exactly the same manner as in the present 9½-in. or 11-in. pumps. It is hardly necessary, therefore, to follow this part of the operation through in detail, as the operation of the standard Westinghouse pumps is not new.

The operation of the air end, however, will be of much interest. On the down stroke air is drawn in through the upper air inlet on the left-hand side of the air cylinder; it passes through the passage *m*, receiving valve 86, *m*, to the low-pressure volume above piston 66. When the piston reaches the lower limit of its stroke and starts upward, this air is compressed until the upper discharge valve 86_1 (on the upper right-hand side of the cylinder) is raised, then the air is forced through port r_1, discharge valve 86_1, passage g_1, receiving valve 86_2 and port m_2 to the annular cavity between the drum portion of piston 66 and the cylinder 63. Since this volume is much smaller than the low-pressure volume, the air is being compressed during its passage from the low-pressure to the high-pressure volumes until, when the piston reaches the upper limit of its stroke, the air in the low-pressure clearance passages and high-pressure volume has reached the intermediate pressure of approximately 40 lbs.

During the following down stroke this high-pressure air is compressed until it raises the final discharge valve 86_3, when it passes through port r_2 and the discharge valve to the discharge orifice in the center piece between the air cylinders.

This same operation occurs in the lower cylinder when the piston goes in the opposite direction from that described above, and as corresponding passages are designated by the same letter, the operation can be readily followed through by reading over the description just given.

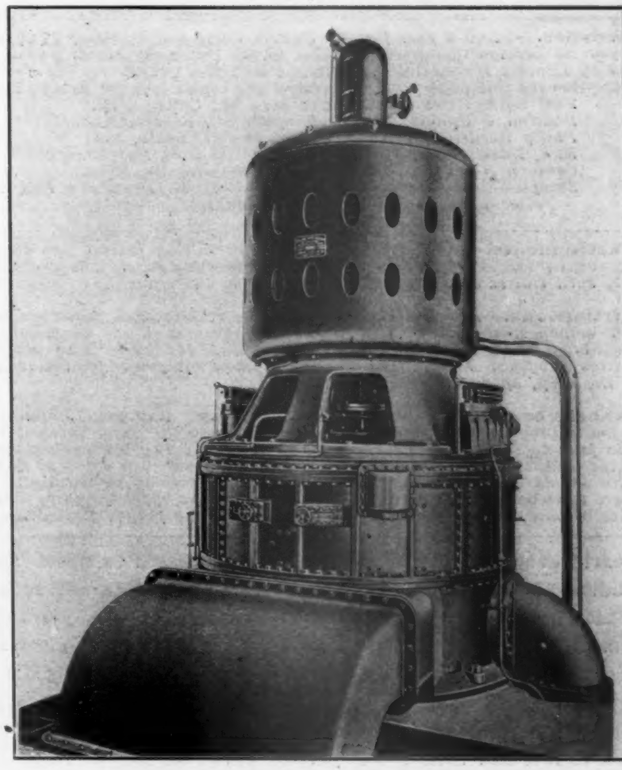
The air cylinder is lubricated by three oil cups, as shown on Fig. 2. The upper end receives its oil from the automatic oil cup placed just to the left on the upper center piece. The piston drum receives its lubrication by the oil from the cup connecting with passage g_1 in the upper air cylinder, and is drawn into the high-pressure volume by the air as it goes from the low pressure to the high. The lower end of the air piston is lubricated by the oil cup situated on the left side of the lower center piece. The last two oil cups mentioned are old style air-cylinder oil cups, whereas the other, and that in the front view of the pump, is the new automatic air-cylinder oil cup. This cup can readily be used for the upper low-pressure cylinder whenever desired.

It is thus seen that the complication due to compounding by this design is materially reduced, and all parts are made strong and durable and as nearly like standard simple pumps as it is possible to make them. In this way the great reliability that has been so prominent a feature of the Westinghouse pumps is made to apply to this pump also.

"It is better to arrive safely after dark than to arrive an hour earlier on a shutter."

CURTIS STEAM TURBINE TESTS.

The following remarkable results were obtained in a series of tests of a 2,000-k.w. Curtis steam turbine generating unit which were recently made under the direction of Mr. Frederick Sargent, of Sargent & Lundy, and Mr. Louis A. Ferguson, of the Commonwealth Electric Company. The turbine operates at 900 r.p.m., and is a four-stage machine designed in 1903 and recently changed slightly as a result of experiments conducted during the past year. The machine as tested conforms as nearly as possible to the standard four-stage machines now being produced, but is less efficient since the changes made have been confined to the buckets, while several other important changes, which are known to be desirable, could not be made in this case without entirely rebuilding the machine. Every precaution was taken to get accurate and reliable results, and repeated tests confirm these results.



2,000-K.W. CURTIS STEAM TURBINE.

Full Load Test:	
Duration of test	1.25 hour.
Steam pressure (gauge)	166.3 lbs.
Back Pressure (absolute)	1.49 in. of mercury.
Superheat	207 deg. F.
Load in kilo-watts	2,023.7
Steam consumption per k.w. hour	15.02 lbs.
Half Load Test:	
Duration of test	0.916 hour.
Steam pressure (gauge)	170 2 lbs.
Back pressure (absolute)	1.40 in. of mercury.
Superheat	120 deg. F.
Load in kilo-watts	1,066 7
Steam consumption per k.w. hour	16.31 lbs.
Quarter Load Test:	
Duration of test	1 hour
Steam pressure (gauge)	155.5 lbs.
Back pressure (absolute)	1.45 in. of mercury.
Superheat	204 deg. F.
Load in kilo-watts	555
Steam consumption per k.w. hour	18.09
Zero Load:	
Duration of test	1.33 hour.
Steam pressure	154 5 lbs.
Back pressure (absolute)	1.85 in. of mercury.
Superheat	156 deg. F.
Steam consumption per hour	1,510.5 lbs.

UNIQUE POSITION OF SUPERHEATING.—One consoling fact in the experimental stage must be remembered—that no risk is being run of a loss, as whatever superheat is obtained is of value, and although if insufficient, the greatest economy is not obtained, the best results will have to be worked up to, as a sufficient amount of evaporative surface must be retained.—*H. H. Vaughan, before Master Mechanics' Association.*

(Established 1832).

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*
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Nearly every successful man will give a reason to which he considers his success due. The editor recently obtained such a reason from an official whom the readers of this journal all know. It was: "When in subordinate positions I always made it a point several times every year of introducing improvements, each of which would pay my salary for the year. It did not require many years for these improvements to be traced to me, and then I was pushed ahead as fast as I could go, and perhaps faster than I ought to have gone. A young man who will do this cannot be held back on a good railroad."

COST KEEPING.

By their cost keeping systems the success of manufacturing enterprises may be measured. As a basis for estimating and conducting manufacturing cost keeping is absolutely essential. By the records of costs the superintendent is guided in his organization and administration in such a way as to intelligently introduce improvements. He is thereby able to compare the efficiency of men, machinery and methods, while without accurate knowledge of costs he would be working in the dark.

Cost keeping may be carried too far as a hobby, but there is vastly more danger of not carrying it far enough. Railroads, as a rule, fail to appreciate the value of cost records, particularly in the shops. These records necessitate providing additional clerical expense, but it is money well invested when it illuminates the operation of the shop and forms the basis of improvements. Those who are becoming interested in this subject and are engaged in establishing simple and inexpensive methods of applying commercial principles to railroad shops are sure to come into prominence, because of their success. Success cannot fail to follow intelligent efforts to improve, and railroad shops offer a broad field for this sort of improvement. It should be easy to secure new and up-to-date machinery if the possibilities of saving could be stated definitely.

THE IMPORTANCE OF TWELVE INCHES.

To meet the requirements of heavier passenger trains a certain road got some heavier passenger engines. They were larger and, presumably, better in every way than those which could not quite make the time. From the first the firemen found their work harder than before, and objected to the engines because of their size. This led to a test for fuel consumption, resulting in showing that with the same schedules and weight of trains, the larger engines were slightly more economical in fuel per ton mile than their predecessors. For a time no one could understand why the work was harder, but it was soon discovered that the tenders of the new engines required the men to carry the coal 12 ins. further than the older ones. As the men handled about 5,000 lbs. of coal per hour, this small distance became important. The remedy was easy, and was quickly applied, after which complaints ceased. This indicates the necessity for care in details of design, in order to render big locomotives as convenient as possible for the men. This is an important matter for the attention of draftsmen, and in such questions of detail draftsmen have an opportunity to show their value to their employers.

SPEED CHANGES FOR MACHINE TOOLS.

There has been a very noticeable tendency during the past year or two to increase the number of mechanical speed changes on several types of machine tools, the aim being to furnish as many changes as possible without making the mechanism too complicated or bulky, and to make these changes with a minimum loss of time and with as little inconvenience to the operator as possible. Such tools as lathes, boring mills and drill presses are, in many cases, now furnished with two, three, four and even more times as many spindle speeds as formerly, while several types of tools which three or four years ago were regarded as requiring only one speed are now arranged for two or more, as is notably the case with planers and some of the boiler shop tools.

Credit for this development is very largely due to the results which have been gained with the individual variable speed motor drive. These motors won their way into the shops largely because of the opportunities afforded by close and convenient speed regulation and brought this question forcibly before the shop managers. That an increased number of speeds, which may easily and quickly be changed is desirable is indicated by the fact that in a large railroad shop, where the machine tools were changed from the belt to the individual variable speed motor drive, the men availed themselves of the additional speeds without any great amount of instruction being given them, and the company considers the increased output due to this change as more than sufficient to have justified them in making the change.

LARGE LOCOMOTIVES.

Where to draw the line in scrapping old and light locomotives and where to draw another in building light ones are questions of importance on Western lines having many miles of branches with comparatively light traffic and poorly ballasted tracks. Good policy in one section of the country may not be good in another, where the conditions are far different.

Much has been heard lately about the policy of building light engines—of about 130,000 lbs., on driving wheels of the 2—8—0 type, and some of the Western lines are doing this and also maintaining locomotives which roads with heavier traffic cannot afford to keep up. This scrapping question is mainly one of track and traffic. If a road has not the business to require heavy locomotives, and has not the track to carry them properly, the case is clearly one requiring light engines. This, however, has been used as an argument against the modern heavy locomotive, which is said to have been unsuccessful.

Wherever traffic is heavy, heavy locomotives are absolutely

necessary, and if they injure the track, break draft gear and are generally difficult to operate and maintain, the conditions must of necessity be improved, and the locomotives must be made successful. It would be a great comfort to every one if a step backward in this matter could be taken, but it will probably never be taken, and locomotives will be still heavier rather than lighter. Heavy locomotives have led to the discovery of many weak spots, but these will be strengthened. It seems to have become axiomatic that where business is heavy locomotives must also be heavy, and the problem is not to make them lighter, but to make the heavy ones satisfactory.

Much is now being said about a return to narrow fireboxes. It is impossible to predict the effect of automatic stokers on firebox design, but unless the stoker changes the situation it seems very unlikely that a return to the old narrow firebox will be made. It seems more logical and more wise to endeavor to overcome such difficulties as have occurred with wide fireboxes, as the wide firebox is certainly necessary with the present large boilers.

In the standard locomotive equipment of the Harriman Lines no provision is made for light locomotives in future equipment. Light engines for all purposes sufficient for many years are believed to be covered by the present equipment, and who can tell what the requirements of 25 years hence may be? It is even predicted that by that time steam locomotives will be found only in museums. Certain it is that the present problem is how to build heavy, powerful locomotives and to operate them properly.

MAN FAILURES VS. ENGINE FAILURES.

A prominent railroad official recently said: "I am tired of hearing so much about engine failures. Casualties to locomotives leading to delays and grief we have in abundance, but the proportion due to actual failures of machinery and boilers is small. Our trouble is 'men failures.'"

Pooling is the worst influence ever introduced into locomotive practice, and as long as it is used it will be difficult, if not impossible, to overcome these men failures. Following pooling came the idea that that operation is best which gives each train the maximum possible number of tons. This is pernicious, fallacious and wrong. Moreover, it is expensive. What is needed is an apostle of economical train operation, who will be broad enough to see the whole operating problem at once and strong enough to compel the investment and the policy which will permit of converting transportation into a commercial transaction.

Heads of departments must conscientiously combine to produce economical results, and they must be willing to allow their personal and departmental records to dissolve into the final returns—net earnings. This involves board-mindedness, concerted effort and team work. The men failures are not confined to enginemen. There is abundant support for the statement that many of the higher officials are far removed from the problems and the men, and for the further statement that many of them do not realize this.

It is not enough to design and build locomotives and roundhouses, tracks and bridges well. It is not enough to design and equip shops well. There is another and far more difficult problem in the use of these factors, in the selection and training of the men to understand them, and who are disposed to secure from them the desired results.

With the increase in size of railroads and the growth of organizations a tendency of serious import has developed. The higher officials are necessarily further removed from the men, and to provide for this a radical improvement must be made in order to insure that at least some one else is near the men.

As armies increase in size this is provided for by maintaining the component units as small as ever. More companies, complete in themselves, are added. The generals are occupied with large questions, and they cannot and must not, deal with the individual man; but the captain is as near the men as ever. The captains are as well trained and the discipline may be as perfect in a thousand as it is in a few companies. From this standpoint to reduce men failures the railroads need more captains, more delegation (but not division) of authority, more responsibility of subordinate officials and more councils of war of higher officials.

Some of the men failures are: (1) Putting green men at work as firemen after but one week of experience on a locomotive and with no previous railroad experience. Such men will forget to put the heater on the left-hand injector, and it will come in frozen on a cold day. (2) Allowing trains to delay long at stations for baggage and mail transfer, which time must come out of the locomotive when running. (3) A policy which renders it possible for a locomotive engineer to earn more in a month than the master mechanic, who is responsible for the work of three hundred engineers, a couple of thousand shop and roundhouse men and various other responsibilities. What else but a man failure can be expected here? (4) The continued use of old shop machinery when new tools will double the capacity. (5) Depriving local officials of reasonable discretion in advancing wages and salaries to specially efficient men. (6) The tendency toward leveling men into classes with horizontal planes of cleavage by rules regulating the maximum rates of wages. (7) The pooling system and indifference to individual responsibility in the operation of locomotives. (8) The tendency toward putting the blame on some other department. (9) The lack of something to take the place of old-time apprenticeship. The too general lack of training of men in their duties and the lack of systematic recruiting systems.

These are enough for the purpose, and it is important to note that these are questions for the presidents and directors to decide. There is reason for hope that they will soon be appreciated.

SELECTING NEW MACHINE TOOLS.

Too much emphasis cannot be placed on the importance of using great care in selecting new machine tools. The price, a photograph and a specification or general description afford a basis upon which to work, but they are not sufficient. The person who makes the selection must be thoroughly familiar with the work which is to be done by the machine, and should personally inspect the various machines which are offered to determine which one is best adapted to handle the work. The first cost of one machine may be much greater than another, but an investigation may show that the increase in first cost will be offset in a few months by the increased output afforded by the higher priced tool. A photograph is often misleading, and does not enable one to study the detail parts closely. The specifications and descriptions are too often written with a view to exploiting the "talking points" of the machine and some of the more common features, which, nevertheless, may be of vital importance as far as the output or accuracy of the work is considered, are sometimes not even mentioned. Too much importance is often given to the comparative weights of machine tools. Weight means nothing if it is not properly distributed.

It is encouraging to note that some of the larger roads are placing the selection of new tools in the hands of a committee composed of those best fitted to judge the merits of the tools from a practical and theoretical standpoint. One road recently sent one of its machine shop foremen to examine the various makes of tools at the works of the builders, and was almost entirely guided by the report which he made. In these days, when rapid progress is being made in improving shop methods and new features are being added to machine tools from time to time which enable them to be more easily operated, and which tend to increase the accuracy of the work and the output, the best results cannot be obtained by considering the tools in a haphazard manner at long distance, or by leaving it in the hands of a person who is not in close touch with the development which is taking place.

COMMUNICATIONS.

A MATTER OF EDUCATION.

To the Editor:

Expecting in your July issue to note further comment on your article, "A Matter of Education," from the June issue, I find that motive power officials have missed another good opportunity to place their men in the right light.

Humanity, with all its follies, is not depreciating as fast as depicted by some of the writers on this question. Look at the matter in its right light and go to the bottom of it, and you will find what is termed in this busy day "Commercialism" in one form. Let those officials, who fear for the future and the kind of men they must use go back to the days of the old men. Were they brought up under the pooling system of engines? Was an engine cared for to keep it in shape to haul its tonnage economically?

With the coming of the large engines, we entered a new phase of operation. Have the higher officials given the motive power department the appliances necessary to meet those conditions quickly and economically, or are they still trying to handle the 100-ton engine with the same shops and tools they did the 50-ton engines? So it is with the enginemen. Are motive power men responsible for the pooling system and shortage of power that has done so much to reduce the men to the "Don't Care" system?

The old-time engineer petted his engine and worked over it. To-day your engineer looks as the men say, "For 6 o'clock and pay day."

Let us educate the engineman and, incidentally, every man in the service, but don't blame the men for what we have largely made them. If the education of the men is not to be lost or appreciated, we must see to it that the higher officials are educated, or become better acquainted with the real needs of the motive power department.

If we are to have contented and efficient men, they must have the proper tools to work with, and it is useless to prate of inefficient men and forgotten coal economy if we give men engines to work with that ought to be in the shop for repairs, and oftentimes rebuilding.

MASTER MECHANIC.

IMPORTANCE OF DRAFTING ROOM WORK.

To the Editor:

In the present day struggle to increase the out-put of the railway machine shop by the installation of larger machines, the use of special tools, and the introduction of high grade steel, the importance and possibilities of the work of the railway drafting office is largely overlooked by many superintendents of motive power. Even in the most modern and best equipped shop the earning capacity of both men and machines is seriously handicapped without proper drawings of the work to be turned out. There is little economy in keeping a $10,000 machine idle while the operator studies out dimensions from an obscure drawing or goes across the shop to get a measurement from an old broken casting. The operator's time as well as that of the machine is lost. Without the drawing the liability of errors and consequent loss by misfits and spoiled material is greatly increased. The dimensions on a well-checked drawing are much more reliable than those computed by the machinist who may not be "quick at figures."

The drafting department should be made up of competent men and should be large enough and well enough equipped to furnish complete and accurate drawings for all locomotives, cars and machines to be built or repaired. It is not enough that there be mere sketches but there should be complete and accurate blueprints of all parts as well as assembled views. Each piece should be detailed, and not too many detailed pieces should be shown on the same card. With the present division of labor there is much in favor of having each piece on a separate card with views and sections enough to make all clear and plain.

The value of a drawing depends largely upon the dimensions given; not only must they be correct but they must be plain and easily caught by the eye. The placing of dimensions on a drawing in the best possible manner requires careful thought, and the draftsman should study each drawing in order to place the dimensions not merely where they can be seen but where the machinist cannot help but see them. A few hours spent by the draftsman to this end will result in a saving each time a drawing is used and considering the number of times one is used the aggregate saving will be many times the draftsman's salary.

There is little doubt that a great many of our railroad companies, large and small, could profitably increase their mechanical drafting force by adding from ten to twenty-five per cent. more *good* men at good salaries and see to it that the shops are furnished clear, accurate and complete drawings of all work to be turned out.

Chicago, Ill.

J. C. AUSTIN.

VARIABLE SPEED FOR MACHINE TOOLS.

To the Editor:

With reference to your recent editorial, page 261 of the July issue, upon the subject of variable speeds for machine tools, the writer would suggest that the ideal method of changing speed would be some means of variation that would quickly cover the desired range of speeds from minimum to maximum gradually, rather than to have a comparatively limited number of speeds with more or less space between them. Such a condition could be fulfilled by two reversed cones with a movable disc between them. This is simply mentioned as illustrating a principle and not as a scheme for actual use upon a machine tool. Such an arrangement would give an infinite number of speeds within its limits and would be ideal as far as speed variation is concerned.

As a means of speed variation, the stepped pulley is notably deficient, as, owing to the small number of speeds obtainable, the percentage of increase or decrease from any one speed to the next one is inconveniently large. With the motor drive the use of a controller having many points reduces this percentage very materially. Consider the 20-in. lathe mentioned in your editorial: as ordinarily built there would probably be a 5-step pulley, which with the back gear would give ten speeds covering a probable range of from ⅜ to 20 in. diameter, with eight intermediate diameters at which the cutting speed will have a uniform rate; then if the limit of work diameter is to be 4 ins. only a few of the ten speeds can be used to advantage. Granting that one-half of the total number of speeds can be utilized the number is manifestly too small to operate the lathe at the best advantage. The fact that a piece of work of a given diameter can be cut at varying speeds, dependent upon the depth of cut, amount of feed, and condition of tool, makes it possible to utilize small increments of speed variation to good advantage. Even a less than 10 per cent. variation is a help if it gives the maximum speed desired. The fact is that with a large number of speeds at hand, the operator has more chance to obtain a desired speed or the best results than where only a few are available. Furthermore a good operator can usually tell by the action of the tool and the general conditions of operation when he has attained about the best speed rate that the tool will stand.

Recent interviews with three superintendents of railway shops brought out the fact that one of them had not thought much about the subject, but the other two had and wanted all they could get in the way of speeds, not that all were necessarily needed, but that the most desirable speed could then be easily obtained. Another thing in favor of a large number of running points is that the change to higher speeds is much less abrupt than where a few only are used. It is true that with special work done upon special machines a smaller number of speeds are needed than where the work is of a general character but it is equally true that small increments of variation are of advantage in either case.

J. C. STEEN, M. E.

RIVETED JOINTS.

To the Editor:

The recent boiler explosion in a Brockton shoe factory has led to much discussion in Massachusetts on the subject of riveted joints. A longitudinal lap seam in an old boiler failed, and the consequent explosion resulted in the loss of about sixty-five lives. In a general way it is admitted that a lap joint is undesirable, but its inefficiency is not fully appreciated because of the erroneous method of calculating its strength. Failures of such seams are common, and are commented upon in some such way as this: "The cause of the explosion is a mystery, for the joint had a factor of safety of 4½. A sample of the plate is to be tested."

The strength of a lap seam can be calculated with greater accuracy than that of any other joint; for the rivets carry nearly equal loads, and, in the case of the double-riveted joint, the plates

stretch practically equally between the two rows of rivets. But the load is eccentric. The tension stress must be considered as consisting of an evenly distributed one, combined with a uniformly varying one which balances a moment, consisting of the load multiplied by half the thickness of the plate. The maximum intensity of the combined stress is four times as great as that of the evenly distributed component, which has hitherto been regarded as the only stress.

Lap joints made of new material have been tested in tension machines. The plates could bend, altering the distribution of the stress until, at the final rupture, it could have been nearly evenly distributed. Upon the results of these tests calculations for the strengths and proportions of seams of this type are based. But, when that material is placed in a boiler, the most stressed edge is subjected to a load insufficient to materially alter the distribution of the load, but still is loaded beyond its elastic limit. It necessarily suffers that gradual change known as "fatigue," losing much of its elasticity, and a crack must start in time. The friction of the plates, the support of the adjoining plates and other secondary causes must now be holding together many lap joints having small factors of safety.

Have we not relied too much on the ultimate strength as ascertained by tests of specimens made of new material? Is not the only safe practice that of keeping the stress of every part of the joint within the elastic limit? And will not accurate measurements of the distortion of every part of a specimen at different loads give the information needed to ascertain what part of the load each rivet and each section of the plate is carrying? Consider, for example, the sextuple-riveted, butt joint in common use now. In designing the joint the rivets are assumed to carry equal portions of the load, but it is not known that they do. The welt strips are eccentrically loaded. Upon their thickness depends the proportion of the shearing each rivet must withstand. The outer row of rivets exerts an eccentric force, and, so far as known, may weaken the joint instead of strengthening it. It would seem that an ideal joint should have all rivets pass through both inside and outside welt strips, and that the thickness of these strips should be decreased toward the edges. A form of joint much used from ten to fifteen years ago consisted of a double-riveted lap with an inside cover strip. This strip was offset over the edge of the inner plate. We can only guess how much of the work is done by the rivets beyond the offset. If, owing to a distribution of the load different from that assumed, any parts of these joints are stressed beyond their elastic limit, cracks will in time develop in them. Then other parts will be similarly stressed and fail, and, if the boiler is kept in use long enough, the last part to fail will cause an explosion.

Lap joints are still used in domes and drums, and for circumferential seams. (A joint consisting of one welt strip outside and none inside is but a combination of two lap joints). Although the steam pressure stresses the circumferential seam but half as much as the longitudinal one, the former is severely taxed by forces transmitted from the frame and cylinders. So long as the elastic limit is not exceeded, the lap joint is perfectly safe for these purposes, but I submit that the calculations should be based on eccentric loading, even if the factor of safety has to be reduced, and that a greater pitch than is now the practice will be found more serviceable.

Waltham, Mass. G. F. STARBUCK.

LOCOMOTIVE GRATES FOR SOFT COAL.

To the Editor;

I have recently come from an anthracite to a bituminous road, and, not having previous experience to fall back on, would respectfully request advice as how to secure information relating to grates for soft coal, drop grates, area of air openings in grates and the amount of grate surface which ought to be provided with facilities for shaking. You may be able to show me a short cut to the desired knowledge.

SUBSCRIBER.

EDITOR'S NOTE.—The best answer to this question appeared in a paper read by Mr. J. A. Carney, before the Master Mechanics' Association last year. As this may serve also to remind others of important questions concerning grates, the following paragraphs are reproduced:

It has been demonstrated that the cheapest fuel for locomotive use is that which can be bought for the lowest prices per ton, and it rests with the railroad mechanical engineer to so design his engine to burn this cheap fuel with the least inconvenience. The ash-pan is so closely related to the grate that it is discussed in this paper in connection with grates. In designing a grate the first object is to properly support the fire; the second, to admit air enough to the fire to properly burn it; the third, to easily and effectually stir the coals and shake down the ashes, and the fourth, to be able to quickly remove the fire at the end of a run; a fifth and most important feature is to be able to quickly and easily clean the fire on the road.

The ash-pan must be tight to prevent loss of hot ashes, and yet have enough openings to admit air freely to the under side of the grates. It must have sufficient volume to carry ashes made during a trip of many hours, and should dump and clean itself with a minimum amount of labor. There should be no flat places where ash can collect and fill up to the grates. While the air openings, according to theory, need be very small, they should in practice be as large as possible and allow the passage of sufficient air to not only burn the fire but cool the grates and accumulations of ash on them as much as possible. Theoretically the air openings in the grates should be of just enough area to admit, without undue friction, a quantity of air needed to replace the hot gases drawn from the firebox.

Estimating the temperature of the products of combustion in the fire-box at 3,500 degrees F., the volume of the gases passing out of the fire-box will be about seven times as great as the air passing through the grates, due to the expansion caused by the high temperature. As all of the gases have to pass through the flues, the openings in the grates and ash pan need be one-seventh of the combined area of the flue openings. According to the above figures, an engine having 44 sq. ft. of grate area and 792 sq. ins. of flue openings, the total area of grate openings should be 114 sq. ins., with 114 sq. ins. opening in the ash-pan. In per cent., with grate area 100 per cent., this equals:

Grate area	100
Flue area	12.5
Grate opening	1.8
Ashpan opening	1.8

The use of the finger grate is somewhat more common than the box construction. The box construction is used in good-coal districts, and while roads report some trouble where the coal is fairly good, others who are using poor coal report an endless amount of trouble. The fingered grate has the advantage of breaking up as well as stirring the fire, while the box grate can only lift and lower the fire, without breaking it up. The only objection to the finger grate is the possibility of burning the ends of the fingers if they are not kept level. This can be entirely overcome by care on the part of the fireman and the shaking mechanism kept in repair. The long-fingered grate is better adapted for poor coal than the short finger. It has a more violent action on the fire, breaks it up better, shakes down ashes faster and gives a larger opening through which the fire can be dumped in the least possible time. Grate fingers less than 5 ins. long do not give as good results with coal which clinkers or which fills up the box as those longer than 5 ins., although the general practice is to run under 4⅞ ins.

Dead grates are used by seven of the roads making replies. These roads use a better grade of coal than that found in the Middle West. As a general proposition, a dead grate is not advisable, especially in the front end of the fire-box, where there is most need of a good fire, especially with wide, shallow fire-boxes. It is easy to accumulate ashes in the front, and if the fire dies and cold air gets next to the flue sheet, it is difficult to make an engine steam.

Most roads have special dumping grates, both in front and in the back end of the fire-box, and the idea has a great deal of merit, especially when it is necessary to clean a fire on the road. These grates should be shaking as well as dumping grates.

Grates should be designed so that the entire grate surface may be shaken. If it is desirable to stir up the fire in the middle of the box, why not on the sides and especially the ends? The area shaken by one lever may vary with the quality of the coal, and if the ash melts and cements the grates tight, the shaking feature is out of the question and all designs are equally bad. The grate area shaken by one lever ranges from 7.2 sq. ft. to 29.8 sq. ft. The grates with the last-named area are used with West Virginia coal and practically no shaking is required. Generally speaking, the grate area to be shaken by one lever should not exceed 12 sq. ft. Some recently built engines have the grate lever fulcrum attached to the back of the boiler head with studs. These studs are liable to pull out and it is safer to attach the fulcrum to the deck or tail-board.

It is impracticable to make grate bars wide enough to extend from one side of a fire-box to the other without a central support. This support prevents air from circulating under the fire in the middle line of the box, and there is a dead space a few inches wide from the front to the back of the fire which will clinker badly if great care is not taken in firing.

PERSONALS.

Mr. L. N. Hopkins has been appointed purchasing agent of the Chicágo, Burlington & Quincy Railway, to succeed Mr. George G. Yeomans, resigned.

Mr. William Alter has been appointed foreman of the car department of the Central Railroad of New Jersey, at Elizabethport, N. J., succeeding Mr. W. F. Girten.

Mr. Thomas Tracy, general foreman of the shops of the Erie Railroad at Kenton, Ohio, has been appointed assistant master car builder, with headquarters at Meadville, Pa.

Mr. George W. Kohler has been appointed road foreman of locomotives of the Chicago, Burlington & Quincy, with headquarters at St. Joseph, Mo., to succeed Mr. Charles Hoffman.

Mr. J. F. Robinson, acting master mechanic of the Seaboard Ail Line at Savannah, Ga., has been appointed master mechanic in charge of the shops at Savannah and Americus, Ga.

Mr. Jacob Kastlin, assistant master mechanic of the Chicago, Burlington & Quincy Railway at Galesburg, Ill., has been appointed master mechanic at St. Joseph, Mo., to succeed Mr. J. H. Dacey.

Mr. J. H. Dacey has resigned as master mechanic of the Chicago, Burlington & Quincy to become master mechanic of the Wabash Railroad at Moberly, Mo., to succeed Mr. George W. Mudd, resigned.

Mr. R. D. Hawkins, mechanical engineer of the Great Northern, has been appointed general master mechanic of the Central district, with headquarters at Minot, N. D.

Mr. C. H. Seabrook has been appointed master mechanic of the St. Louis Southwestern Railway Company, with headquarters at the Pine Bluff shops, Pine Bluff, Ark. The office of general foreman has been abolished.

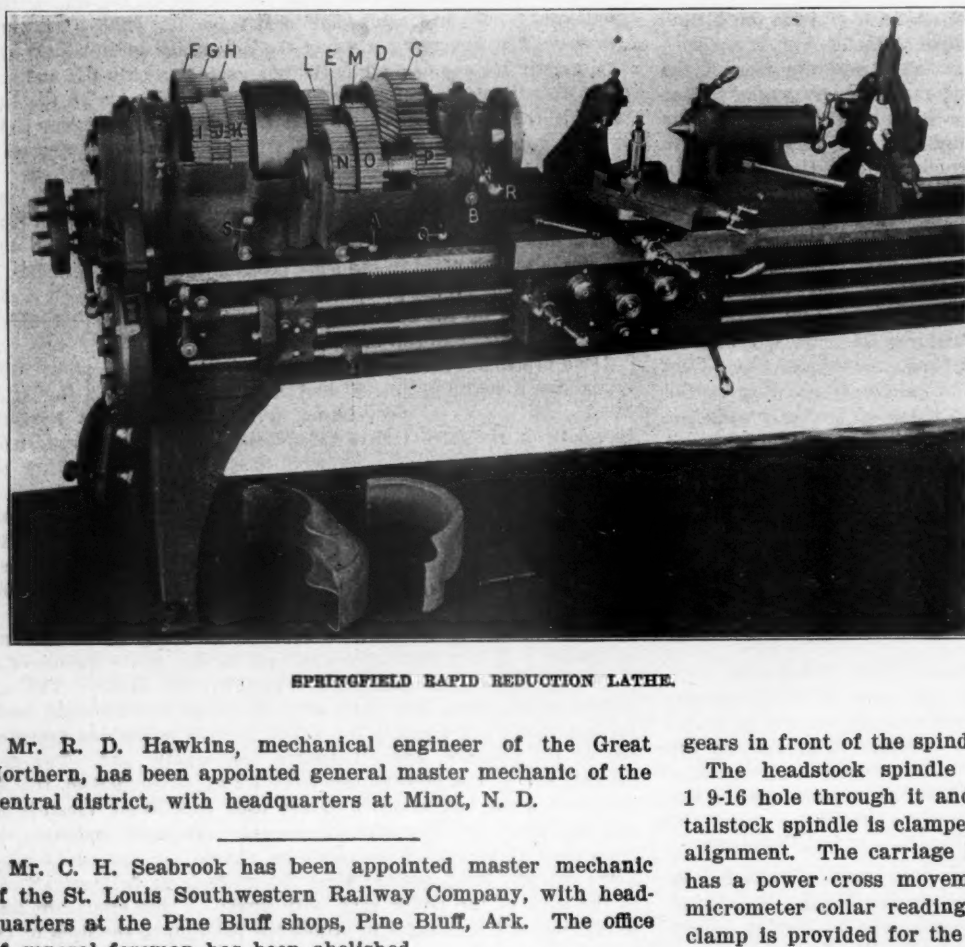
Mr. Charles Hoffman has been appointed master mechanic of the Southern Railway with headquarters at Princeton, Ind. He leaves the position of road foreman of locomotives of the Chicago, Burlington & Quincy at St. Joseph, Mo.

Mr. George G. Yeomans has resigned as purchasing agent of the Burlington to become assistant to Vice President Delano of the Wabash. Mr. Yeomans will have charge of the purchasing for the entire Wabash system.

19-INCH RAPID REDUCTION LATHE.

A new rapid reduction lathe, having a capacity sufficient to swing a piece 19 ins. in diameter in the rough, is shown in the accompanying illustration. This lathe was carefully designed with a view to working the high speed steels to the limit of their capacity and to furnish a sufficient number of spindle speeds in geometrical progression for all practical purposes. The head stock is of very heavy proportions and ample power is provided by a 4½-in. belt over a 12-in. single face pulley which runs direct upon the spindle at a moderate speed. With a two-speed counter shaft 20 spindle speeds are obtainable as follows: Two direct belt speeds are obtained by a positive clutch operated by the handle A connecting the driving pulley to the spindle. Six speeds are obtained when the lever A is in the position shown and the face gear C is connected to the spiral gear D by a positive clutch operated by the lever B. Gear D is driven by a pinion keyed to the shaft E. Three gears, F, G and H, are mounted loosely upon shaft E and any one of them may be connected to the shaft by an internal positive clutch operated by the handle S. These gears mesh with I, J and K, which are keyed fast to the pulley.

Twelve more spindle speeds are obtained through the double back gears which are placed in front of the spindle. The face gear C is disconnected from the spiral gear D allowing the latter to revolve freely upon the spindle. Keyed to the spiral gear D are two gears, L and M, either one of which may engage with back gears N and O driving the spindle through pinion P and face gear C. It is impossible to injure gears N and O, as they are positively locked in one or the other driving position by a hook upon lever Q, which also affords means for sliding the gears from one position to the other, this lever receiving its locking and unlocking motion from the handle R, which has an eccentric projection extending through the housing in which the back gear shaft is mounted, with an eccentric bush at the other end. It will be seen that with this arrangement of gearing the higher speeds, which are used for the finishing cuts are the two direct belt speeds and the six speeds through the spiral gears which produce a smooth motion. The remaining twelve geared speeds are for roughing and for heavy cuts upon large diameters. Placing the back gears in front of the spindle relieves the caps of any strain.



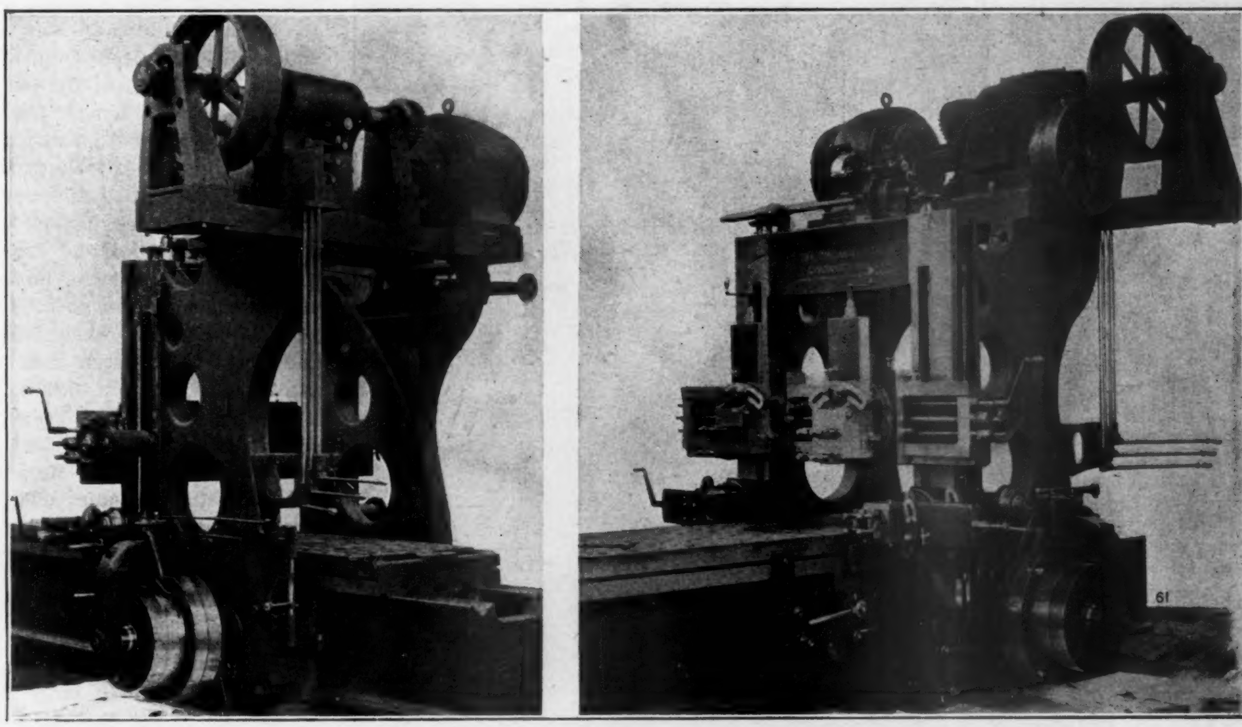
SPRINGFIELD RAPID REDUCTION LATHE.

The headstock spindle is made of crucible steel with a 1 9-16 hole through it and runs in self-oiling bearings. The tailstock spindle is clamped by two bushes insuring its proper alignment. The carriage has one V and one flat bearing and has a power cross movement, the cross feed screw having a micrometer collar reading to 1-1,000 of an inch. An effective clamp is provided for the carriage for use when facing. The apron is double, furnishing two bearings for all studs, and the rack pinion has a bearing supporting it close to the rack and may be withdrawn when screw cutting. The lathe shown in the illustration is equipped with the Ideal rapid change gear mechanism, which was described on page 27 of our January, 1903, issue, but if desired it may be equipped with a positive

gear feed—giving six variations of feed—and regular change gears. The compound rest is of a heavy pattern and fitted with taper gibs to take up the wear. The screw has a graduated collar reading to 1-1,000 of an inch. The counter shaft is of simple design, having one tight pulley and two friction pulleys of an improved form. This lathe is made by the Springfield Machine Tool Company, Springfield, Ohio.

42-INCH MOTOR-DRIVEN FORGE PLANER.

The Pennsylvania Railroad has recently installed three 42-in. forge planers, two at Wilmington and one at Trenton, which have several noteworthy features. They were made by the Cincinnati Planer Company, and are of an entirely new heads are controlled by handles which travel up and down with them, and are, therefore, always convenient to the operator. These side heads are similar to those used on the cross rail, are very rigid, and may be run below the level of the top of the table when not in use. The cross rail is raised and lowered by means of the patent power lifting device, which was described in detail on page 194 of our May, 1904, issue. The driving pulleys have been increased in width, and are furnished with oil reservoirs, which insure their being properly oiled with a minimum amount of attention. The pulley shaft, which is the only high-speed shaft in the machine, is made ring oiling and has Lumen bronze bearings. These machines were made by the Cincinnati Planer Company, Cincinnati, Ohio.



CINCINNATI NEW MOTOR-DRIVEN FORGE PLANER.

design from the ground up. They are driven by Westinghouse 20-h.p. constant speed motors, and by means of a speed box are arranged to furnish six cutting speeds ranging from 22 to 51 ft, per minute, with a constant return speed of 80 ft. per minute. The changes in cutting speed can be made either while the machine is in operation or standing idle by means of the three levers shown at the right in the photograph. The gears in the speed box are of steel and are completely encased in a cast iron box, which holds several gallons of oil. This oil is also used for lubricating the bearings; the gears carry it to the top of the box, and it passes into the various oil chambers which have openings at the bottom, allowing it to drain back after encircling the shafts, and thus keeping a constant flow of oil on all the revolving parts and reducing the wear and noise to a minimum. The beds are made of extra length, so that there is very little overhang of the table when planing at full stroke. The V's are also made much wider than usual. The tables are made deeper, and have a set of dogs and a complete shifting mechanism on each side. The housings are carried down to the floor, and in addition to the usual bolts and dowel pins are secured to the bed by a long tongue and groove.

The cross rail has a very large bearing on the housings, and is strengthened by an arch-shaped brace at the back. The heads are of a new shape, the end of the tool block and slide being made round to avoid projecting corners on angular work. They are provided with taper gibs and the slides are hung on ball bearings. An automatic tool lifting device is also furnished, which is not shown in the photographs. The side

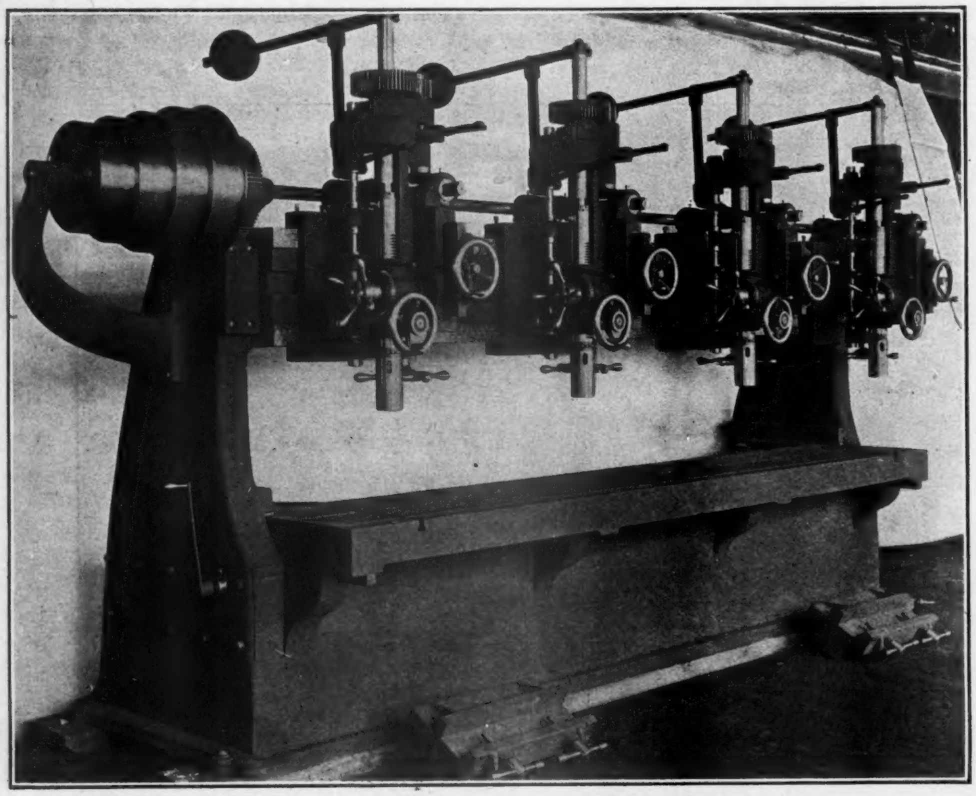
Improved Machinery in Railway Repair Shops.—The great disparity between different shops, both in the time and the cost required to make locomotive repairs is being brought to the attention of financial men in railway management and the opposition to appropriations for shop improvement, has been materially lessened, now that great savings have been demonstrated by many of our up-to-date shops. There is no reason why the repair shops of the railways of the United States, having a yearly payroll of more than one and one-half million dollars, or greater than any other single metal working business in the country, should not be put on a manufacturing basis and provided with modern machinery.—*Progress Reporter.*

Premium Plan for Shopmen.—Mr. W. E. Symons, speaking before the Western Railway Club, said that, largely due to the introduction of a premium plan in the shops, the output of a boring mill, which for ten years had never bored to exceed 20 wheels per day, was increased to 60 and 70, and frequently 80 wheels per day. He said: "Improved machinery, of course, must be installed for various kinds of operations, and without that no shop can compete with the better equipped shops that are so provided. But unless the management in charge of the shops has control of its men, receiving their loyal support and best effort, it makes no difference what kind of machines you install, you will never get good results."

Blacksmiths' Association.—The National Railroad Blacksmiths' Association will hold its next convention at the Forest City House, Cleveland, Ohio, August 15 to 17, inclusive.

MULTIPLE DRILL WITH COMPOUND ADJUSTABLE HEADS.

The machine shown in the accompanying illustrations was made specially for the Omaha shops of the Union Pacific Railroad, and was designed to meet the demand for a flue sheet drill which is absolutely independent in all motions to the spindles. The spindles may be set out of line as much as five inches from each other, and it is thus possible to drill a staggered layout of holes within this limit without moving the table. The machine will take a sheet 12 ft. 4 ins. wide between its housings, and the table is provided with 24 ins. of cross adjustment. The chucks shown in the foreground of Fig. 1 are for holding mud rings; the front side of the base of the machine is 8 ins. back of the center line of the spindles, so that when drilling mud rings they can extend down from the chucks into a pit in front of the machine.



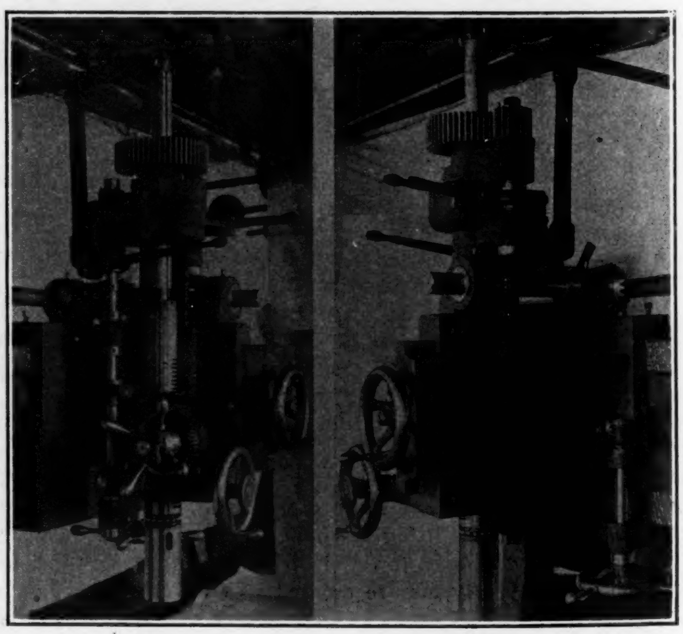
MULTIPLE DRILL WITH COMPOUND ADJUSTABLE HEADS.

Each head is absolutely independent in all its motions, and each spindle may instantly be started or stopped by means of a clutch which is operated by a lever. The feeds are so designed that a change from the feed required for drilling to that for reaming may instantly be obtained by pulling a lever. As the feeds are positive, a safety clutch is provided, so that the feed will slip, if due to carelessness on the part of the operator, the nose of the spindle should strike the work. The heads are adjustable on the cross rail by the hand wheel which operates through the worm and spur gearing. An automatic knock-off permits the feed to be thrown out at any point. The spindle is provided with a quick return motion and also with a hand feed through worm gearing. The spindles are of forged open hearth steel, with ball bearing thrust collars, and have 12 ins. of vertical power feed. The heads are carefully designed for rigidity when the spindles are in the extreme outer position and working under the most severe conditions. Each one of the heads weighs 965 lbs., and this will serve to give some idea as to their strength and size. This machine was made by Foote, Burt & Company, Cleveland, Ohio, and weighs complete about 12 tons.

Mail Service.—The United States Post Office Department handled last year 9,502,459,535 pieces of mail matter.

AMOUNT OF AIR REQUIRED FOR VENTILATION.

Under the general conditions of outdoor air, namely, 70 deg. temperature and 70 per cent. of complete saturation, an average adult man, when sitting at rest in an audience, makes 16 respirations per minute of 30 cu. ins. each, or 480 cu. ins. per minute. With 70 deg. temperature and 70 per cent. humidity, the air thus inhaled will consist of about one-fifth oxygen and four-fifths nitrogen, together with about 1 7-10 per cent. of aqueous vapor and 4-100 of 1 per cent. of carbonic acid. By the process of respiration the air will, when exhaled, be found to have lost about one-fifth of its oxygen by the formation of carbonic acid, which will have increased about one hundred-fold, thus forming about 4 per cent., while the water vapor will form about 5 per cent. of the volume. In addition, the exhaled air will have warmed from 70 deg. to 90 deg., and, notwithstanding the increased proportion of carbonic acid—which is about one and one-half times heavier than air—will, owing to the increase of temperature and the levity of the water vapor, be about 3 per cent. lighter than when inhaled. Thus it will be seen that this vitiated air will not fall to the ground, as has often been presumed, but will naturally rise above the level of the breathing line, and the carbonic acid will immediately diffuse itself into the surrounding air. In addition to the carbonic acid exhaled in the process of respiration, a small amount is given off by the skin. Furthermore, 1½ to 2½ lbs. of water are evaporated daily from the surface of the skin of a person in still life. If the air supply at 70 deg. is assumed to have a humidity of 70 per cent. and to be saturated when it leaves the body at a higher temperature, then at least 4 cu. ft. of air per minute will be required to carry away this vapor.



DETAILS OF HEADS OF MULTIPLE DRILL.

Taking into consideration these various factors, it becomes evident that at least 4½ cu. ft. of fresh air will be required per minute for respiration, and for the absorption of moisture and dilution of carbonic acid gas from the skin. This, however, is only on the assumption that any given quantity of air, having fulfilled its office, is immediately removed without contamination of the surrounding atmosphere; but this condition is impossible, for the spent air from the lungs, containing about 400 parts of carbonic acid gas in 10,000, is immediately diffused in the atmosphere. The carbonic acid does not fall to the floor as a separate gas, but is intimately mixed with the air, and equally distributed throughout the apartment.

It must then be evident that ventilation is in effect but the process of dilution, and that when the vitiation to be maintained in the apartments is decided, the necessary constant supply of fresh air to maintain this standard may be very easily determined. For the purpose of calculation, 0.6 cu. ft. per hour is accepted as the average production of carbonic acid by an adult at rest, and the proportion of this gas in the external air is as 4 parts in 10,000. If, therefore, the degree of vitiation of the occupied room be maintained, say, at 0.6 parts in 10,000, there will be permissible an increment of only 2 parts in 10,000 above that of the normal atmosphere, or 2 divided by 10,000 equals .0002 of a cu. ft. of carbonic acid in each cu. ft. of air. The 0.6 cu. ft. of carbonic acid produced per hour by a single individual will, therefore, require for its dilution to this degree 0.6 divided by .0002, equals 3,000 cu. ft. of air per hour. Upon this basis the following table has been calculated:

Cu. ft. of Air Containing 4 Parts of Carbonic Acid in 10,000 Supplied Per Person.

Per Hour.	6,000	4,000	3,000	2,400	2,000	1,800	1,714	1,500	1,200	1,000	525	375	231
Per Minute.	100	66.6	50	40	33.3	30	28.6	25	20	16.6	9.1	6.2	3 8
Degree of Vitiation of the Air in the room. (Parts of carbonic acid in 10,000.)	5	5 5	6	6.5	7	7.33	7.5	8	9	10	15	20	30

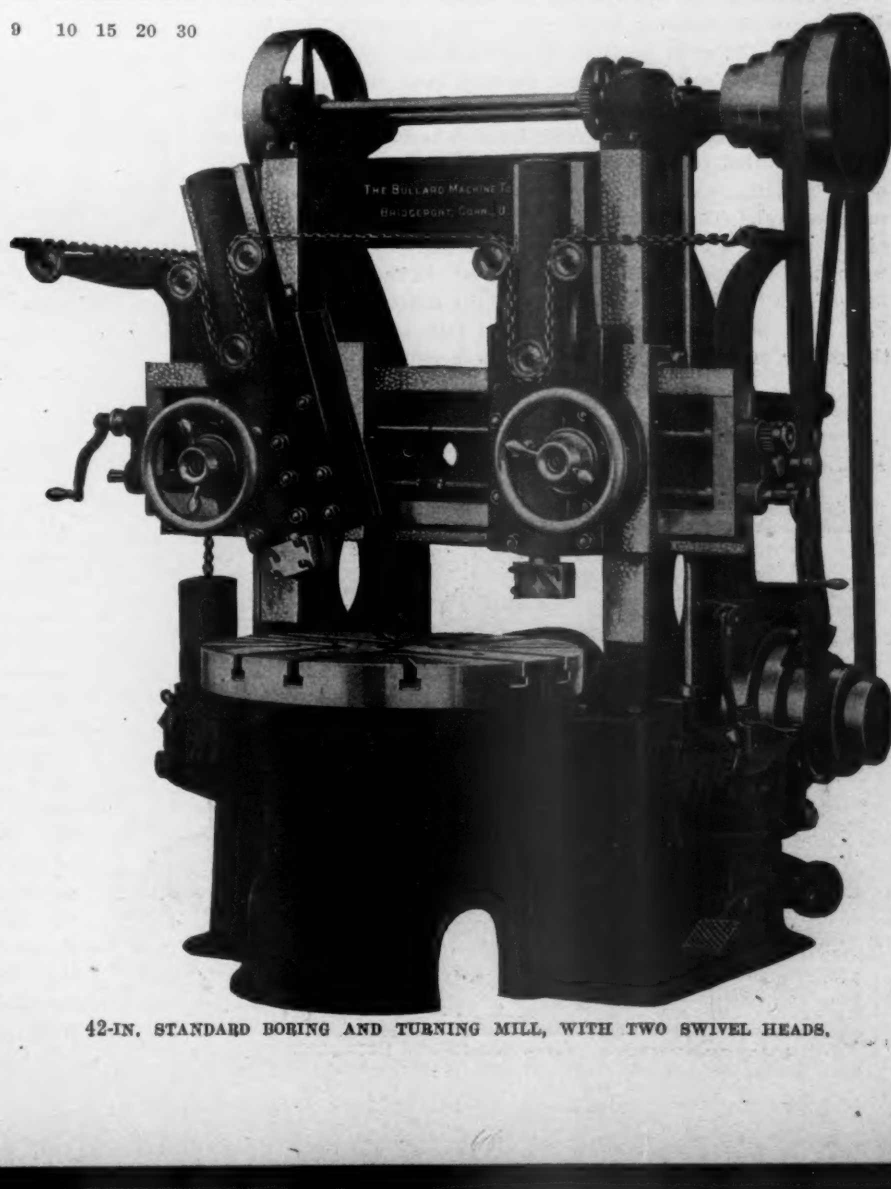
The figures indicate absolute relations under the stated conditions, and are generally applicable to the ventilation of schools, churches, halls of audience and the like, where the occupants are reasonably healthy and remain at rest. But the absolute air volume to be supplied cannot be specified with certainty in advance, without a thorough knowledge of all the conditions and modifying circumstances; in fact, the climate, the construction of the building, the size of the rooms, the number of occupants, their healthfulness and their activity, together with the time during which the rooms are occupied, all have their direct influences. Under all these conditions, it is readily seen that no standard allowance can be made to suit all circumstances, and results will be satisfactory only in so far as the designer understandingly, with the knowledge of the various requirements as they have here been given, makes such allowance.—*Extract from Treatise on Ventilation and Heating, by B. F. Sturtevant Company, Boston, Mass.*

New Tool Steel.—The Sheffield *Daily Independent* states that the Sheffield Steel Makers, Ltd., are putting a new tool steel known as "Unor" on the market, which has a cutting and wearing capacity ranging between Mushett and the best high-speed steel, is easily hardened and can be sold at a very reasonable price.

42-INCH BORING AND TURNING MILL.

The record of one hundred and twenty-two cylinder packing rings in ten hours at the West Albany shops of the New York Central Railroad, which was described on page 235 of our June issue, has excited considerable attention, and a description of the machine upon which this record was made will be of interest. The machine is a Bullard standard 42-in. boring and turning mill, with two swivel heads, and has a capacity in height of 32½ ins. The table is 37½ ins. in diameter, and is driven by bevel gearing at its extreme diameter. Due to a large angular thrust bearing the table spindle has a self-centering tendency, and the weight of the table and spindle and the work upon the table tends to preserve rather than destroy the alignment. The side strains are taken by straight vertical bearings of large proportion. Ten changes of spindle speed ranging in geometrical progression are provided, and a change to any desired speed may instantly be made by a mechanical belt shifter which is built into the machine. The belt cannot twist or run off the cone, and it is automatically locked in position at each step. The table may be stopped instantly at any desired point by a brake which is operated by a lever conveniently placed.

The cross rail is of a heavy box section, is very rigid and is square locked throughout. It is raised and lowered by power independent of the table drive. The heads are entirely independent in their movements, both as to the direction and amount of feed, and either head may be brought to the center for boring, a positive center stop being provided. The tool bars have a vertical movement of 20 ins., and may be set at any angle up to 45 degs., either side or the center. Ten positive feed changes are provided, ranging from 1-32 to ¾ of an inch horizontally, and from 1-50 to ½ in. in vertical and angular directions. The feed works for each head are independent, and, as will be seen, are very conveniently placed for the operator. A safety device incorporated in each speed



42-in. Standard Boring and Turning Mill, with Two Swivel Heads.

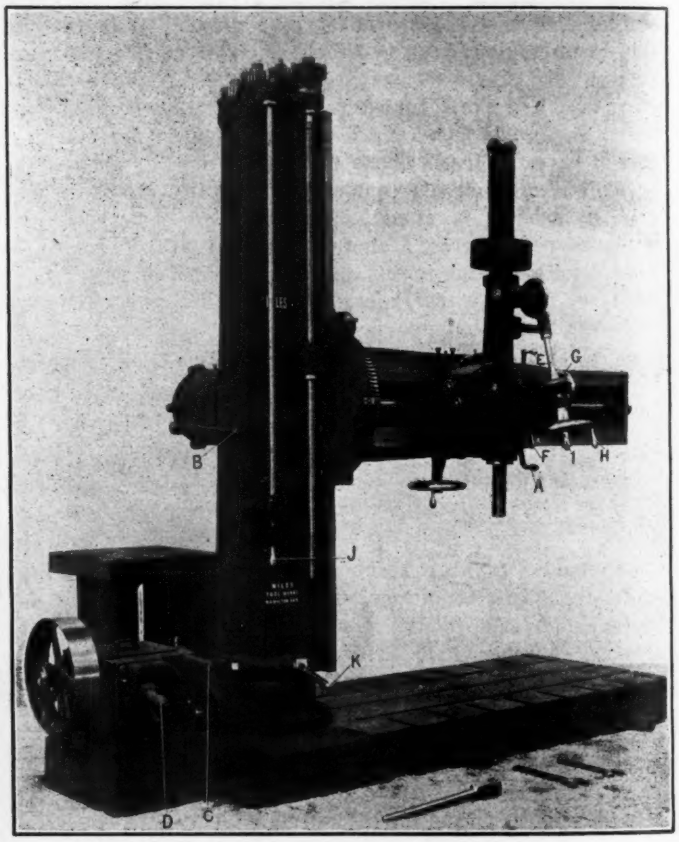
works prevents breakage of the gears or mechanism by careless handling of the heads.

A 5-h.p. constant speed motor may be mounted on a bracket at the side of the machine and connected to the top shaft by either a belt or silent chain, or a 7-h.p. variable speed motor having a speed range of one to four may be direct connected by either gearing or silent chain to the head stock driving shaft, thus doing away with the cones. The net weight of this machine, which is made by the Bullard Machine Tool Company, Bridgeport, Conn., is 11,000 lbs.

SIX-FOOT UNIVERSAL RADIAL DRILLING MACHINE.

The 6-ft. full universal radial drilling machine, illustrated herewith, while designed specially for the use of high speed drills, has a sufficient range of spindle speeds to adapt it for the use of carbon steel drills also. It is the result of the experience of the five works of the Niles-Bement-Pond Company in the design and manufacture of radial drills and is noteworthy because of its ease of manipulation and the fact that all parts which require adjustment by the operator are within easy reach. The drill head saddle fits between, as well as outside of the arm guides, which completes the double box section of the arm and insures rigidity. The column saddle is strongly gibbed to the flat bearing on the column and the post about which the column revolves extends to the extreme top of the sleeve. The column rests on ball bearings. Friction clutches are used for starting and stopping the machine at high speeds in order to prevent shock and the consequent wear. All speeds and feeds may be changed while the machine is running at even the fastest speeds. The speed box is planed on top in order that the machine may easily be changed from a belt to a motor drive by simply replacing the pulley by two gears.

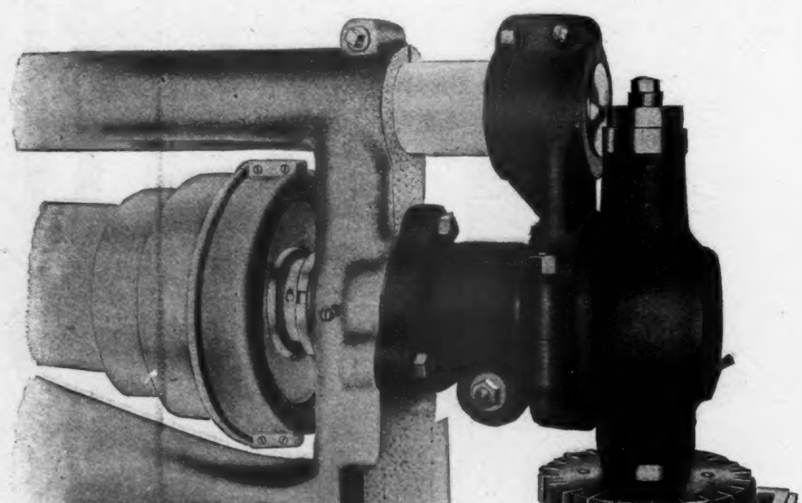
Sixteen speeds and eight feeds are provided. The lever A starts and stops the spindle and reverses it for tapping. Lever B operates the friction back gears. The handle C furnishes two speeds for each position of the tumbler gear handle D. The handle E furnishes a fast or slow feed for each of the four positions of the lever F. The hand wheel G is used in connection with the hand feed hand wheel H and has the double function of operating either the friction or the spindle quick return, depending on the up or down position of the pull-clutch I. The handle J controls the raising or lowering of the arm at a speed of from 20 to 70 ins. per minute. The wrench K clamps the sleeve to the post. The maximum distance from the face of the column to the center of the drill is 77½ ins; the least distance from the face of the column to the center of the drill is 22½ ins.; the greatest distance from the spindle to the base plate is 72 inches and the spindle has 20 ins. of traverse.



UNIVERSAL RADIAL DRILLING MACHINE.

NEW VERTICAL MILLING ATTACHMENT.

A powerful but very compact and simple vertical milling attachment for use on horizontal milling machines has just been brought out by the Kempsmith Manufacturing Company, Milwaukee, Wis. It has been designed to handle a very heavy class of vertical milling, and is capable of doing as heavy work as the strength of the main spindle itself will stand. The bevel gears in the head are of steel, case hardened, and have large faces and coarse pitch. In order to maintain a perfect alignment the vertical spindle has very long bearings, and provision is made for a delicate adjustment for wear. The head is graduated and may be swiveled to any angle. Its construction is such that only two bolts are required for adjusting and securely clamping it, and both of these bolts are very conveniently located for the operator.



VERTICAL MILLING ATTACHMENT.

The horizontal bolt which clamps the head in the bracket is of the friction type and has very great clamping power. The vertical spindle has a taper hole, and is threaded for the large face milling cutters; both the taper hole and the thread are the same as those on the main spindle, thus making all tools interchangeable. Draw bolts are furnished for drawing in and backing out of end mills. As will be seen from the illustration, the design of the head is such that the distance from the center of the horizontal spindle to the nose of the vertical spindle is very short, so as to allow as much space as possible between the table and the vertical mill. This attachment is built in three sizes, which are drilled to the same jigs as the columns of the machines for which they are intended, so that they may be applied to any Kempsmith miller of certain sizes now in use.

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Shop Layouts.

Committee—C. A. Seley, R. P. C. Sanderson.

Few roads are so situated that one shop could take care of all their heavy repairs even if that were desirable, which we believe not. We do not at this time wish to take a stand for or against the large shop, meaning the extreme size possible. That question must be determined by the road or system for itself, viewing the question from the standpoint of road layout, organization, labor facilities, etc. The very large shop presents an opportunity for tying up the road by fire, strikes or accident that is not present when several smaller shops are used. On the other hand, it is hardly feasible to provide the smaller shops with all of the facilities and refinements now thought essential in the equipment of the large shop, and by these we mean not only the machine tools and handling appliances, but the multitude of small tools and appurtenances not generally reckoned or appreciated. Many roads lack in proper repair facilities at terminals and division points where the stitch in time saves many an engine failure. No matter how large and complete the main shop may be, the outlying points can advantageously and profitably use a moderate tool equipment for taking care of running and light accidental repairs, leaving heavy repairs and manufacturing to be done at the main shops. With such an equipment and organization, we believe that relatively small shops are undesirable, expensive and unprofitable, and that the larger, completely equipped main shops will handle the repairs in the most satisfactory manner.

The railroads represented in this association have all kinds of shops, many of them capable of improvement, and in the last few years there has been a number of large shops built, no two on the same general plan, yet embodying more or less of the strictly modern lines of improvement in buildings, equipment and facilities. Railroad managements, owing perhaps to traditional conservatism, have not been quick to grasp the improvements in shop processes and equipment that are deemed essentials in other lines of business. It is true that railroads are not manufacturers, as a rule; but if the repairs of locomotives and cars involve the same processes to a great extent as in their manufacture, either the manufacturers of railway equipment and machinery are unduly extravagant in providing roomy, well-lighted buildings, traveling cranes and hoists, electric transmission of power and lighting, special tools of latest designs, all tending to labor saving or putting the workmen on a better plane, or else the railroads are neglecting their opportunities and daily paying for it in the increased cost of their repairs.

Most of us, doubtless, have visited many shops where locomotives, cars and heavy machinery are built, and we could not help contrasting the methods of the successful manufacturers with those of the average railroad shop. If we analyze the matter and seek the reasons governing the situation on railroads, we find, first of all, that the average shop is planned and equipped for handling the average locomotive of say 10 or 15 years ago and with machinery, much of it, of a greater age. During that period we have increased steam pressure 25 per cent., increased tractive power 50 per cent., increased total weight 75 per cent. and tank capacities of 7,000 and 8,000 gals. are now common, an increase of nearly 100 per cent.

The demands of our managements for high speed and heavier tonnage to meet competition have brought about the development of machines for hauling trains that put the crack engines of a few years ago on the branch lines and on second-class trains or in the market for sale, to make way for heavier power. Wheels under the engines have been multiplied and so have cylinders. Rods are now so heavy that it takes a gang of men to handle them. Everything about the engines is on a larger scale, but how about the shops?

It is quite plain to our managements that it takes twice as long to water an engine with the 6-in. standpipes that were good enough in the old days and they see the necessity for enlarging on that line to cut down time.

Is it not equally important to supply facilities for handling the locomotive parts that have perhaps doubled in weight since the old shops were built? It used to be considered good enough to jack up an engine or, perhaps, to have a drop table for wheeling, and we are still doing too much of it, a practice that would be ridiculed by any live business man whose profits depended on modern methods of handling.

Now, whose fault is it that so many railroad shops are behind the times? It may be the fault of the management in not approving the recommendations of live motive power officers, who are awake to the situation and see their maintenance expense rising and are unable to check it on account of lack of facilities. The heavy modern engines do not stay out like the old timers and shoppings are more frequent, demanding greater shop facilities for a given number of engines than was necessary when engines were lighter, trains were shorter and time was longer. Some roads may think they are too poor to make these expenditures, and, of course, they should have our sympathy if this were true, but it is not.

Based on the principle that a manufacturing business will be most profitable when conducted with a plant, equipped with modern appliances, labor-saving devices for economical production, well organized and rationally directed; a railroad shop to be most efficient should be equally well equipped, organized and directed.

It is stated, however, in some quarters, that although the argument may be good, it has not been proven by the results obtained at the large modern shops, and that many old shops are yet more efficient that the new. It must be admitted that there is much of truth in this, but for reasons which, perhaps, can be explained and the difficulties to some extent can be overcome.

Some shops have been built in which the money has been expended for ground and buildings and then these are filled with back-number machinery. In this case, aside from improved facilities for handling, no gain in the cost of the machine work is accomplished. A road with such a shop will need to make purchases of extra motive power in order to do business. When buying engines, if they would cut off one or two and expend their value in tools, the balance of the power could then be brought up so that the extra engines cut off would not be needed. It is not a question of how many engines a road has, but how many good, serviceable engines, and this depends on the facilities for repairing and keeping engines running. In this connection it is suggested that a system of cost keeping for manufactured work and various operations will shed much light on the comparative value of old and new machinery. The development in tool improvement and the use of high-speed steels has made large economies possible, the exact amount of which can only be determined by an accurate cost keeping system, which can very profitably be carried out in the larger shops.

Another shop, equally well located and built, is equipped with a large line of modern tools, new from the makers. The shop is started and the management expects immediate results and they are not forthcoming. Why? Because the shop lacks that important equipment of the old shop in small tools, cutters, mills, jigs, formers, templates, bars, blocking, clamps and handy appliances that the old shop has been years in accumulating. The new shop will be handicapped for lack of these for some time, as they are an unappreciated asset in the business of the old shop.

Other well-equipped shops have been built at new points where the management deemed wise to locate, but almost invariably this has been the cause of long delay in getting together an organization to work the shop up to its capacity.

Railroad shop work cannot be successfully performed by the floating element. A large proportion of the force must be permanent, settled in homes, convenient to schools and churches and other advantages and have something to live for beyond the empty honor of being an employe of the great North, East, South and West Railway.

No matter how well built and equipped the shop may be, its efficiency will be measured to a great extent by the class of men that can be obtained to work it. Unless the railroads are wise enough to see to it that they must, to a certain extent, bring the shops to the men, they will fail in getting the best material.

In order to get and hold the proper class of men, shop work should be fairly constant. Frequently the motive power department is embarrassed by the difficulty in getting appropriations for maintaining force and organization at times when business is slack. When business is good, engines are worth from $25 to $50 per day, or perhaps more, and every day in the shop or out of service is that much loss. When business is dull and the full locomotive equipment is not needed, the engines needing repair could then be put through the shops and laid up ready for the return of business. By thus keeping engines up a less number is needed, investment being devoted to maintenance, instead of multiplication. There is no doubt of the results of having a uniformly good standard of equipment, as against a lot of cripples, helped out with occasional new engines, often of new design, requiring time and considerable expense in getting patterns and repair parts.

The matter of recruiting for shop forces is one that is assuming considerable importance. We are not now making the all-around mechanics, which most of us were some years ago, equally at home on the machines, the bench or on the floor. The apprentice question is a vital one, deserving the attention of not only the motive power officers, but the higher officials as well. As the older methods seem to be outgrown, new methods of recruiting must be tried, including, possibly, educational courses in connection with the shop work.

The difficulty of getting suitable men for foremen in smith shops and boiler shops is particularly noticeable. The spirit which at present dominates workmen is one apparently not elevating the more worthy or ambitious ones among them, but rather establishing a dead level of mediocrity from which it is difficult to select leading men for foremen and places of responsibility.

Some of this has been brought about by the increasing distance between the officers and the men, due to increase in the size of railroads, in many cases now amounting to many thousand miles and a vast number of men. Formerly a motive power officer knew almost every man on his pay-roll, and this personal contact, although not necessarily amounting to familiarity, nevertheless contributed to a spirit of *esprit de corps* that was invaluable in preserving organization, conserving good feeling and enabling prompt settlement of all questions.

Owing to the inability of the head of the motive power department of a great railroad to frequently visit outlying shops and terminals, this spirit is lost unless it is fostered by subordinate heads. The growth by combinations, etc., of railway systems in the last few years have been so rapid that we have not had the time or opportunity of impressing this feeling on subordinates to the extent that it should be. Furthermore, in these expansions of railroads it is sometimes the case that the jurisdiction of subordinates is increased so as to cover too much territory, or in the case of foremen, they have too many men to handle to the best advantage. With the decreasing individual capacity of workmen, superintendence, supervision and instruction are more necessary than ever.

Suppose we have the big shop. It remains to get the best out of it, despite the possible drawbacks that have been named, and discover a policy, if possible, necessary for the success of these shops and the other big shops that are to come. As the big engines are handicapped by the small water cranes, small roundhouses and other small things, it is a possibility that the big shop is handled in a small way by a small man or, perhaps, by a big enough man, but tied down by small regulations and restrictions that do not permit him to do what could be done if he were more of a free agent. It is not well to give a small man a free hand, as he will make mistakes and is not equal to developing large

things. The successful manufacturers have very competent men at the heads of their departments and they pay them salaries that railroad managements would deem extravagant for men having equal responsibility and the disbursement of, perhaps, greater amounts of pay-roll. The railroads must realize that for superior service, they must meet the salaries paid by the manufacturers. They have lost many a good man, who, while greatly desiring to remain in railway service, could not afford to do so in view of the inducements offered by the manufacturers. The railroads get more of what may be called professional service, not only in the motive power department—work of men who have to fit themselves by long training, by study and earnest effort—for less money than almost any other line of business.

For a successful shop manager, the man must not only have practical and technical knowledge and experience, but must have tact and a knowledge of men and affairs, dignity, yet with all a familiarity that will make the humblest employe feel that he has a friend, yet one that he must respect.

The complicated labor problems of to-day will not be less complex in the future. The proper labor equipment is so vital a factor in the successful operation of shops or business that the small man, or even the large man who has but limited opportunities, may fail in handling that feature in management.

The larger shops also present an opportunity for manufacturing on a very profitable basis the repair parts for storehouse stock and subsequent shipment to outside points.

The extent to which this may be done is almost entirely limited by the machine facilities of the shops, such extra work demanding extra machinery. The output of the shops in engines should not be affected one way or the other by the manufacturing, which should be separately accounted for and properly credited. Many large shops do a great deal of work outside of the requirements for repairs of engines which they actually have on hand, and this, together with work for the other departments, such as bridge jobs, maintenance of pumping machinery, etc., form a very large portion of the output of many shops.

Manufacturing methods can also be extended to cover many of the regular shop operations, and by doing so this work can be reduced to a business basis, done on business methods.

Regarding the presentation of standard shop layouts, your committee has decided that it is best not to recommend any certain types, but to reproduce the articles on that subject contributed recently to the American Engineer and Railroad Journal by Mr. R. H. Soule, originally chairman of this committee. Mr. Soule was obliged to resign from the committee on account of the loss of health, and we regret losing the benefit of his assistance and advice in the preparation of this report.

The articles give the latest complete descriptions and analysis of the important railroad shops of this country and include data covering smith shops, car shops, stores, roundhouses, etc., but for the purposes of this report only those portions relating to erecting, machine and boiler shops are included, and these have been revised sufficiently to bring them up to date by including all data possible to obtain relative to the latest shops built.

The original articles by Mr. Soule were published in the American Engineer and Railroad Journal in February, March, April, May, June, October, November, December, 1903, and in January, February, March, April, May, June and July, 1904.

Locomotive Front Ends.

Committee—H. H. Vaughan, F. H. Clark, Robert Quayle, A. W. Gibbs, W. F. M. Goss.

Your Committee on Locomotive Front Ends begs to state that at the last convention of this association a motion was carried authorizing the Executive Committee to appropriate, at its discretion, such funds as were necessary to carry out the series of experiments outlined in the report of this committee which was then presented, when money for such work should be available. It was then supposed that it would be necessary to await the receipt of funds raised by the subscription then contemplated for representative membership, but at a meeting of the Executive Committee held subsequent to the convention the secretary was instructed to issue a circular letter to the various railroad companies and locomotive builders in the United States, asking for subscriptions to enable the American Engineer tests on locomotive front ends to be carried out to a conclusion. The responses to this letter were generous and immediate, and a total amount of $3,035 was contributed by the following railroad companies and locomotive builders:

American Locomotive Co.	$ 215.00
Ann Arbor R. R.	10.00
Baldwin Locomotive Works	215.00
Buffalo, Rochester & Pittsburgh Ry	20.00
Bessemer & Lake Erie R. R.	10.00
Canadian Northern Ry	10.00
Chicago & Western Indiana R. R.	10.00
Chicago, Lake Shore & Eastern Ry	5.00
Colorado Midland Ry	10.00
Canadian Pacific Ry	90.00
Cincinnati, Hamilton & Dayton Ry	10.00
C. H. Cory	10.00
Chicago, Burlington & Quincy Ry. (West)	40.00
Chicago, Burlington & Quincy Ry. (East)	80.00
Chicago & North-Western Ry	130.00
Chicago & Eastern Illinois R. R.	20.00
Cincinnati Northern Ry	10.00
Cincinnati, New Orleans & Texas Pacific Ry	10.00
Central New England Ry	10.00
Chicago, Indianapolis & Louisville Ry	10.00
Cleveland, Cincinnati, Chicago & St. Louis Ry	50.00
Chicago, Milwaukee & St. Paul Ry	100.00
Cumberland Valley R. R.	10.00
Chicago Great Western Ry	30.00
Chicago, Rock Island & Pacific Ry	110.00
Chicago & Alton Ry	20.00
Duluth, Missabe & Northern Ry	10.00
Delaware, Lackawanna & Western Ry	60.00
Duluth, South Shore & Atlantic Ry	10.00
Duluth & Iron Range Railroad	10.00
Delaware & Hudson Co.	30.00
Elgin, Joliet & Eastern Ry	5.00
Erie Railroad	25.00
Grand Rapids & Indiana R. R.	10.00
Great Northern Ry	70.00
Galveston, Harrisburg & San Antonio Ry	30.00
Illinois Central Railroad	110.00
International & Great Northern Ry	10.00
Intercolonial Railway	20.00
Kansas City Southern Ry	10.00
Long Island Railroad	25.00
Lake Shore & Michigan Southern Ry	50.00
Louisville & Nashville R. R.	50.00
Michigan Central R. R.	40.00
Maine Central R. R.	10.00
Minneapolis, St. Paul & Sault Ste. Marie Ry	10.00
Mobile & Ohio R. R.	10.00
New York, New Haven & Hartford R. R.	25.00
New York, Ontario & Western Ry	10.00
New York, Chicago & St. Louis R. R.	10.00
Nashville, Chattanooga & St. Louis R. R.	20.00
Norfolk & Western Ry	60.00
Northern Pacific Ry	90.00
Oregon Short Line	10.00
Oregon Railroad & Navigation Co.	10.00
Pennsylvania Railroad	300.00
Penna. Lines West	120.00
Pittsburgh & Lake Erie R. R	10.00
Pere Marquette R. R.	30.00
Richmond, Fredericksburg & Potomac Ry	10.00
Southern Ry.	110.00
St. Louis & San Francisco R. R.	70.00
San Pedro, Los Angelos & Salt Lake R. R.	10.00
Seaboard Air Line Ry	30.00
Southern Indiana Ry	10.00
San Antonio & Aransas Pass Ry	10.00
Southern Pacific Company	90.00
Texas & Pacific Ry	30.00
Toronto, Hamilton & Buffalo Ry	10.00
Terre Haute & Indianapolis R. R.	10.00
Union Pacific R. R.	50.00
Virginia & South-Western Ry	10.00
Wisconsin Central Ry	10.00
Western Ry. of Alabama	10.00
Wheeling & Lake Erie Ry	10.00
Wabash R. R.	40.00
Total	$3,065.00

Your committee was thus furnished with the necessary funds to carry out the work assigned to it, but unfortunately the testing plant at Purdue University was then occupied with other experiments, and could not be released for the purpose of carrying out the tests on locomotive front ends. These experiments have not yet been concluded, but we are pleased to advise that arrangements have been made whereby the New York Central has kindly offered to loan us a locomotive by October 15 of the present year, at which time Purdue University will make arrangements to receive it. The tests that it is proposed to make have been modified somewhat from the outline given in 1904 report, and your committee begs to present the following scheme of experiments for the criticisms of this association, which will, of course, be carried out on a New York Central engine having large front end diameter, which will decide the relations between large and small front ends:

1. Diameter of Stack.—It is proposed to conduct tests involving four different diameters and two different heights of outside stacks of dimensions set forth by Sketch 1, the lower stack to have a height normal to the engine, the higher to have a height 18 ins. greater than this. The diameters to be 15, 17, 19 and 21 ins., respectively. It is expected that data thus derived from a boiler of large diameter will serve in checking formulæ based upon results obtained from the small boiler of the Purdue locomotive, or in case they do not check, it will serve in the establishment of new formulæ. All stacks, of whatever diameter or height, are similar in form. The curvature of the base is the same for all, and the distance from the lower end to the point of greatest contraction is the same. Above the point of greatest contraction all have a uniform taper of 2 ins. to the foot.

2. Inside Stacks.—To determine the value of the inside stack, it is proposed to employ four different diameters and three different lengths, all to be used in connection with an outside stack of height normal to the engine. The proposed stacks are shown by Sketches 2, 3 and 4. As in the case of the outside stacks, the inside stacks are similar in form, all being the same in the curvature of their base, the distance from the point of greatest contraction to base, and in the degree of taper of the upper portion of the stack.

3. False Tops.—For the purpose of determining the effect of blanking off the top of the smokebox, it is proposed to construct a false top, which may be used in connection with stacks having 12 and 24-in. inside projection (Sketches 2 and 3). Each top will have in the center a circular opening reinforced by an angle iron (L), this opening to be sufficiently large to admit stacks of the largest diameter. To make connection with the stacks of different diameters, filling rings will be employed, made up of two angles and a sheet-iron plate, as shown at M. N, Sketch 7.

4. Draft Pipes.—It is proposed to employ single-draft pipes having diameters 13, 15 and 17 ins. and lengths from 18 ins. to 48 ins., lengths to increase by 6-in. increments. Each increment is secured by adding a new section, as shown by Sketch 6.

Experiments upon double-draft pipes will be made to involve the apparatus already outlined. To give facility in adjusting the draft pipes, it is proposed to have them so mounted that they may be raised or lowered by means of levers extending outside of the smokebox. The details of this arrangement are suggested by Sketches 5 and 6. By reference to these figures, it will be seen that two columns (*a a*), having their support in an extension upon the exhaust pipe, are provided as guides for the draft pipes. The draft pipe *b* slides freely on these columns, being applied thereto by some form of fitting which will admit of easy adjustment.

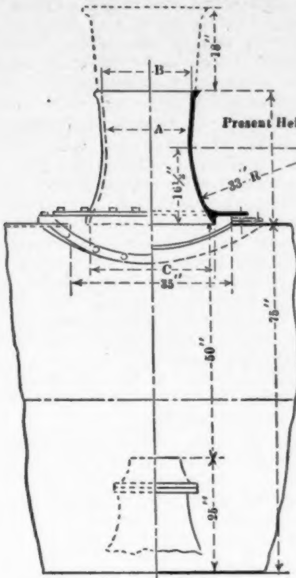


Fig. 1

Stack	A	B	C	Top	Base
	17"			Make	—
	19"			Make	—
	21"			Make	—
	15"			Make	—

Note- All stacks in Figs. 1,2,3 & 4 increase 2" diameter for each foot of height above choke
Note- Outside stacks are to be made of two heights, same as present stack and 18" greater

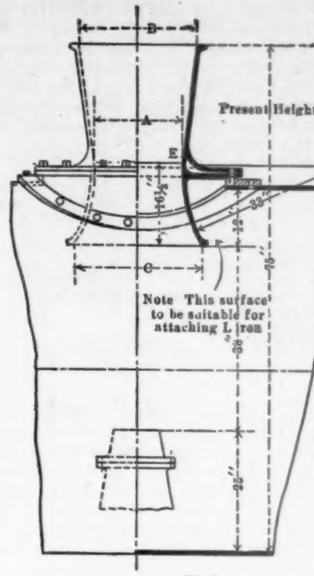


Fig. 2

Stack	A	B	C	Top	Base
	17"			Make	Make
	19"			Make	Make
	21"			Make	Make
	15"			Make	Make

Note- Top and base of all inside stacks must have a finished joint at E

Section E

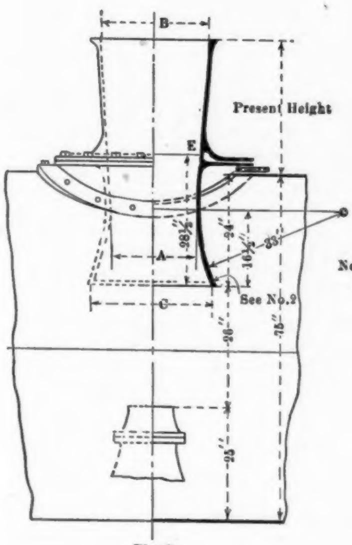


Fig. 3

Stack	A	B	C	Top	Base
	17"				Make
	19"				Make
	21"			Make	Make
	15"				Make

Note- For detail of finished joint at E see Fig. 2

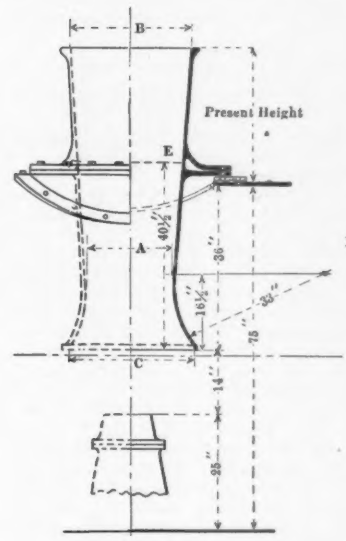


Fig. 4

Stack	A	B	C	Top	Base
	17"	-	-	—	Make
	19"	-	-	—	Make
	21"	-	-	Make	Make
	15"	-	-	—	Make

Note- For detail of finished joint at E see Fig. 2

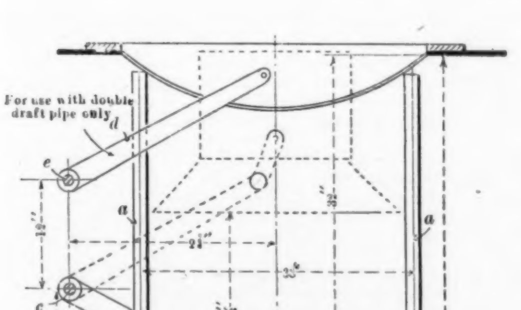


Fig. 5

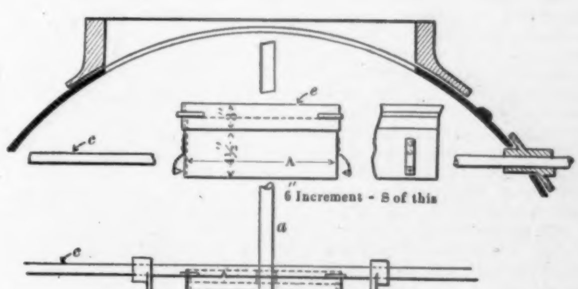


Fig. 6

LOCOMOTIVE FRONT END TESTS.

The vertical position of the draft pipe *b* is controlled by its connection with the lever arm *d* and the shaft *c*. The latter is supported by bearings attached to the smokebox shell, and extends out through the shell a sufficient distance to receive a counterweight and operating lever not shown in the drawings. By having the operating lever pass over a graduated scale, it is thought that it will be possible to place the draft pipes in definite positions without the necessity of opening the front door.

It will be seen that your committee is not carrying out the instructions under which it was appointed, so far as experimenting

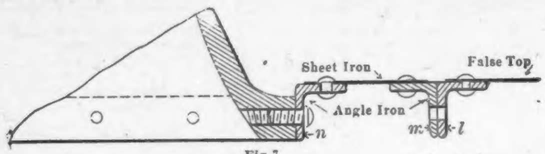


Fig. 7

on the elimination of the diaphragm is concerned; this has been shown by the experiments on the testing plant at St. Louis to be a most important factor in the proportion which the draft utilized in burning coal bears to the total draft produced, but in view of the information that has been obtained on this subject at St. Louis, your committee considers that further experiments on the testing plant would be valueless. Assuming that the first requirement is to obtain a self-cleaning front end, it will require lengthy and practical experimenting to ascertain what design will afford the self-cleaning feature with the least obstruction to the passage of the front end gases, and your committee feels that this subject will have to be determined by experimenting on engines in actual road service before any useful work in this connection can be done upon the testing plant.

Water Softening for Locomotive Use.

Committee—J. A. Carney, L. H. Turner, F. N. Risteen, J. F. Dunn, Robert Quayle.

There are two classes of waters commonly used for locomotives—scale-forming and alkaline. In both the impurities remain in the boiler either to form an accumulating scale or a concentrating alkaline solution, or both. The scale-forming material can either be removed from the water by heat or by chemical means. There is no known means of removing the alkali. The advantages of supplying a boiler with a clean water practically free from scale-forming material are shown by the boiler records of roads fortunate in having first-class water supplies, where fireboxes last almost indefinitely and flues are reset only when the beads are worn off.

The first attempt at water purification and general railroad practice in this country was to use a boiler purge—soda-ash or some allied sodium salt—generally put into the locomotive tank. This process precipitated the scale-forming material in the boiler as mud, and also tended to loosen up the scale already formed in the boiler, but it did not lessen the number of necessary washouts to any extent and required frequent blowing off, which did not effectually remove the mud, and, in addition, there was an accumulation of alkali in the water in the boiler not easily controlled. Theoretically, a boiler purge for purifying water in the boiler was nearly perfect, but practically it was not so successful. Treatment of water in the boiler has the advantage of being cheap, and that is all.

In order to obtain the pure water condition of a few of our fortunate neighbors, the practice of purifying the water before it enters the boiler has come into extensive use. The lime and soda-ash treatment has been used in some form or other for a great many years, but the mechanical devices for making the process successful, as well as economical, are of recent origin.

It is not the province of this committee to discuss the merits or demerits of the various mechanical devices on the market; further than to say, that they all work on one principle, namely, use enough soda ash (sodium carbonate) to precipitate the sulphates of calcium and magnesium as carbonates, and enough slaked lime (calcium hydrate) to neutralize the carbonic acid existing as free carbonate and bicarbonate, precipitating all of the carbonates of lime and magnesia in the water and also precipitate as carbonate all of the hydrate of lime added in the treatment process. The process is theoretically perfect and in practice leaves so little scale-forming material in the water that the beneficial results are most apparent.

There are two systems of treating waters; the continuous and intermittent. The continuous system consists of a device for mixing the required quantity of slaked lime and soda-ash in the water as it flows into a receptacle of such size that the slow flow of the water permits the precipitated scale-forming material to settle out, delivering continuously the purified water. Some continuous processes apply a filter to make sure that the sediment is removed from the water. This is believed to be a valuable addition to any plant where such a filtering process would be considered an addition. The advantage of the continuous process is that it takes up a minimum ground space. The intermittent system consists of treating the water and letting it settle and pumping the purified water from the top of the settling reservoir, using a floating intake pipe. The advantage of this system is low first cost. The settling process requires agitating machinery and time, and a settling plant can not be forced beyond its capacity without jeopardizing the quality of the purified water. In both systems the cost of chemicals is the same for a given water. The labor cost ought to be the same, if the men doing the pumping can be located so they can attend to the filter as well as the pumps.

Muddy waters are easily cleared of the greater part of the suspended matter, but it is almost impossible to render them absolutely clear unless a coagulant, ferric hydrates or alumina, is used. The slight murkiness in treated muddy water is not seriously objectionable, however.

Filtering plants are more complicated and more expensive than either the continuous or intermittent systems and usually depend upon a partial settling in order to relieve the filters from becoming quickly clogged. They deliver the cleanest water of any of the purifying processes, but it is a question whether the water is enough better to warrant the increased cost.

The quality of waters which can be treated successfully and with great benefit to locomotive boilers are those which may contain mud, sulphates of lime and magnesia, and carbonates of lime and magnesia, or which may contain salts of iron and free acid. Many alkali waters contain large quantities of incrusting solid. These can be removed, but the alkali remains and increases by the amount of soda-ash used. If the water is high in alkali, it will give trouble from foaming, and the probability is that it will be more economical to hunt up a better supply somewhere else that can be treated successfully. The results obtained from the treatment of dolomite waters are entirely successful, resulting in better steaming engines, greater tonnage hauled and a marked reduction in engine failures from leaking flues.

Analyses of waters containing from 5½ to 60 grains of incrusting solids per gallon show reduction by the treatment ranging from 3 to 5 grains of incrusting solids per gallon.

Alkali waters are those containing salts of sodium and potassium in solution, and there is no known chemical means of removing these salts. There are a number of articles on the market which claim to relieve troubles from foaming with alkali waters and some of them are partially successful. It is not, however, the province of this committee to discuss their merits or demerits. The only way to get rid of alkali is to remove the water from the alkali. This can be accomplished by distillation, but up to the present time the cost of plant and comparatively high cost of product make the process prohibitive for railroad use.

A purifying plant, 500,000-gallon capacity daily, can be erected for from $6,000 to $10,000, according to the process used, and the water successfully treated for scale-forming material, for from ¾ cent to 4 cents per 1,000 gallons, depending upon the quality of the water.

By the use of pure water, boiler troubles are reduced to a minimum. One railroad reports that the number of trains abandoned account leaky flues was reduced from 27 to 2 in a stated period. Another reports that passenger trains delayed account leaky flues on a division using purified water have been reduced from 12 to 15 per month, to 1 and 2, and an occasional month with no failures. A road handling 60 engines per day has reduced its boiler-maker force from 4 to 2 men—one day and one night—and these men have to be given machinist work to keep them busy.

Your committee does not recommend the use of compounds to be introduced into the boiler where there is a possibility of purifying the water before it reaches the boiler.

Your committee believes that the cost of purifying water for locomotive use is more than saved by the reduction in the labor cost of caring for boilers in the roundhouse, and the benefit gained by freedom from leaky flues and poorly steaming engines on the road is all profit.

Locomotive Terminal Facilities.

Committee—D. R. MacBain, C. E. Chambers, P. Maher, W. R. McKeen, Jr.

"What can be done to reduce locomotive terminals to the basis of a machine for treating and handling of engines apart from the matter of housing, the object being the prompt handling of power, greater efficiency in service and less detention at terminals, while affording more time and better facilities for care and repair of engines?"

Plan No. 1, which is shown in attached diagram, will be offered as the "old plant made over." It will be noted that the space available, at the time the change was made, was very limited, and the engineering department had to cut to fit conditions. A description of the plan is as follows:

The coming-in track, upon which all engines are left by the road crew.

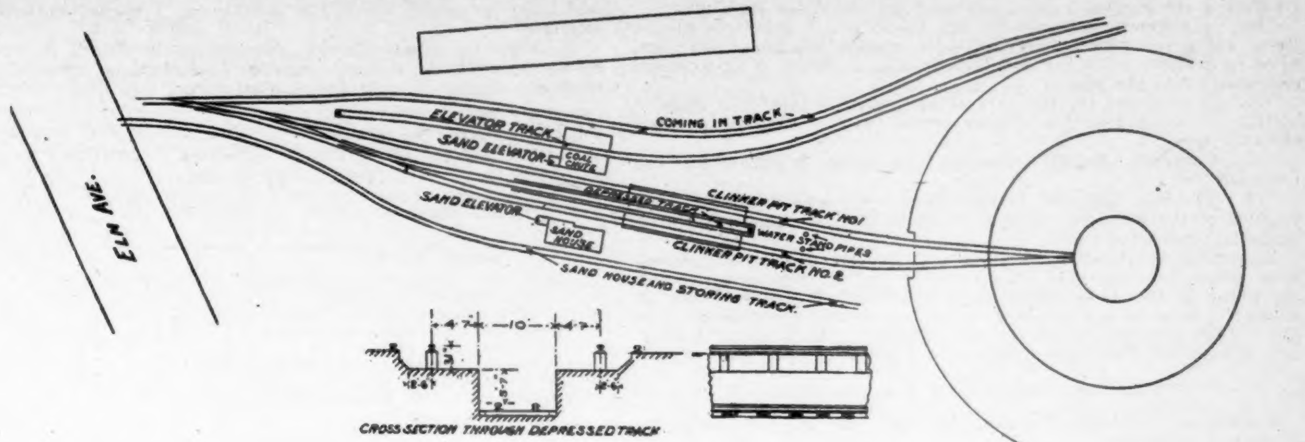
An elevator track, stubbed at one end and with sufficient rise for its whole length in the clear, to enable elevator men to move cars on or off the hoppers at will by the manipulation of the hand brakes and perhaps a little start with a pinch bar. Power is also provided for the movement of cars on and off the hopper, but is seldom used.

Clinker-pit tracks Nos. 1 and 2, both of which run to the turntable direct, and the depressed track for cinder cars, the approach of which is laid on a 2 per cent. grade.

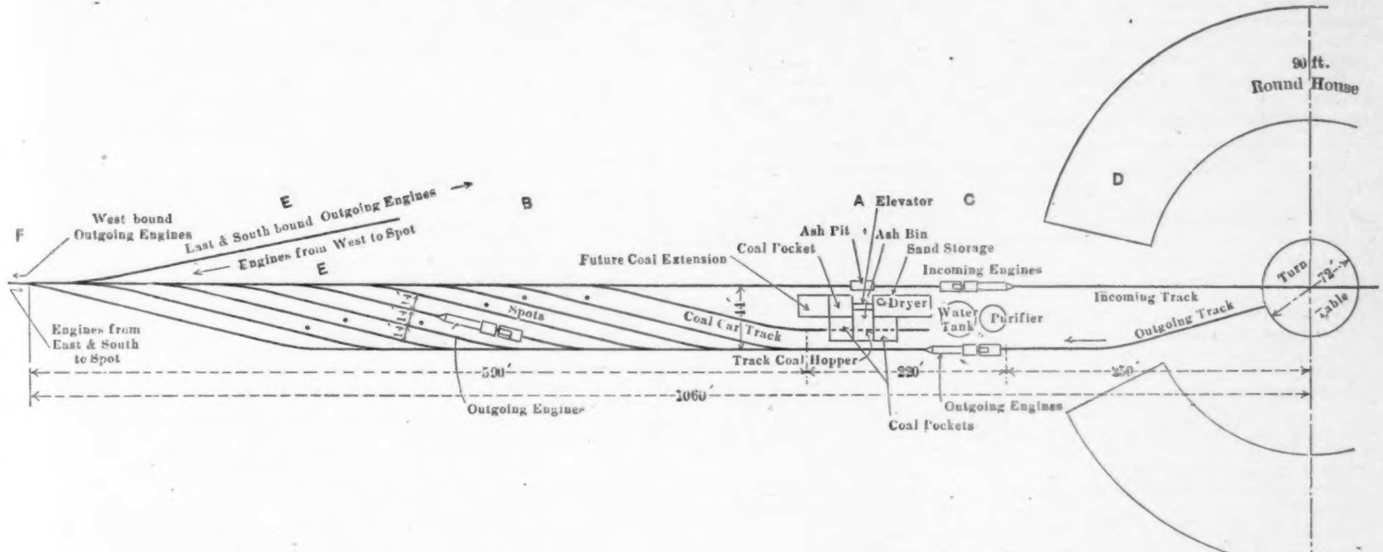
The coal elevator, which is the latest improved type of the Chicago Link Belt Company, and has a capacity of 500 tons.

The sanding boxes, which are placed as follows, one on the corner of the coal elevator adjoining the clinker-pit track No. 1, and another adjoining clinker-pit track No. 2 on the corner of the sandhouse proper. The sanding of engine is done by means of drop pipes, which are handled by hostlers, the time required for filling the largest boxes being about fifteen seconds. The sandhouse is equipped with three stove dryers, and sand is elevated into sanding boxes by means of compressed air. Storage is provided for about twelve carloads of wet sand, which is unloaded from cars placed on sandhouse and storing track. The sanding box on clinker-pit track No. 2, on sandhouse proper, is large, having a capacity of about ten cubic yards, and out of this box sand needed for outside points is loaded into cars placed on sandhouse track, by means of a drop spout or chute. Nine or ten yards of sand in this way can be loaded in a few moments.

Each of the clinker-pit tracks is provided with a 10-in. water column, and tenders are filled very quickly, the filling of tenders being the last operation before engines are put on the turn-table. This is not as the plant was planned, it being intended that the knocking out of the fire should be the last operation, but conditions of space made that impracticable.



PLAN NO. 1.



PLAN NO. 2.

LOCOMOTIVE TERMINAL FACILITIES.

The cross-section of the clinker-pit track shows the general plan, the inner rail (100 lbs. per yard) being supported on cast iron piers which are jacketed with No. 10 iron, the remaining space on the inside filled with concrete, tie rods at 10-ft. spaces being provided along open space of clinkering tracks to prevent possibility of rails spreading. The clinker pits and depressed track are of solid concrete and good drainage is provided. Two hydrants are provided on each clinkering track for wetting cinders, and a steam pipe is provided for thawing out ash pans and grates when such is needed.

In preparing this plan it was sought to make it as near a "machine" as possible, and the results obtained during the past winter were not disappointing in that respect.

Engines arriving off the road are left on the "coming-in track," and when they come in in quick succession, as is the rule in the winter or during any season of heavy traffic, no attempt is made to coal all of them on the north side of the elevator, hostlers usually alternating—that is, one is coaled on the north side and the next on the south side, or, if necessary, several engines are taken off the coming-in track at once and coaled up on clinker-pit track No. 1. In this way it will be observed that when necessary to get hold of, say, the sixth engine in line, the first five engines can be taken at once on to clinker-pit track No. 1, and the engine that is most desired can then be coaled on the coming-in track, after which it can be taken around on to clinker-pit track No. 2, sanded, clinkered, watered and housed, in from fifteen to twenty-five minutes from the time of its arrival.

All engines when going out for trains use a track provided for that purpose alone, and in no way interfere with the putting in of engines, except when on the table. The outgoing track is also provided with a water column to serve engines leaving the house.

The regular equipment of men is six hostlers and six clinker-pit men, three of each for the day and night shifts, respectively, and 100 engines are handled in twenty-four hours without difficulty or rush.

In addition to the duty of clinkering, the clinker-pit men also attend the switches at west end, unload the wet sand, run the dryers, elevate sand to sanding boxes, attend to water columns and shovel the cinders on to the cars on the depressed track.

The equipment of men for the coal elevator is one elevator man, one dumper and one loader for each of the day and night shifts, or seven men all told, including the fuel foreman.

At the present time coal is being handled from the car to the tender for 3 7-10 cents per ton, and this could be reduced considerably if enough coal was used to keep the help around the elevators busily employed.

Your chairman considers this plant as approaching closely to the "machine" idea and of sufficient capacity to handle 200 engines per day of twenty-four hours without difficulty.

Plan No. 2, as shown on the attached diagram, provides, as will be noted, a set of tracks upon which incoming engines can be spotted by the road crew, where they are left until the hostlers take them out for coaling, clinkering and housing. The object of the spot tracks is to permit of the last engine to be the first one housed, if such is desired. This plan, it will be noted, requires a lot of space, longitudinally at least, and perhaps could not be utilized at all points on this account. We quote in full the recommendations of Mr. W. R. McKeen, Jr., the designer of this plan:

"Railroads are just commencing to realize the importance and necessity of adequate roundhouse facilities. Efficient results from roundhouses have always been demanded, but necessary facilities have, as a rule, been sadly neglected. Following are some of the important facilities a roundhouse should have:

"1. What is known in the yard language as a 'spot'—a system of tracks connected to the inbound track in the yard, also connected to the main coal track leading to the roundhouse table; this system of tracks to be so designed as to enable at least ten engines to be delivered by inbound engine crews, any one of which can be moved to coal chute in preference to the other nine at any time.

"2. An outbound 'spot' track and a water crane, so that outbound engines could take a full tank of water just before leaving; also water cranes so that inbound trains could take water immediately after taking coal.

"3. A double cinder pit and means of wetting down and cleaning ash pans economically.

"4. Method of loading cinders into the ordinary steel car equipment by means of conveyors.

"5. Turn-table not less than 85 ft. with (preferably) an electric motor as power for handling same.

"6. Door with at least 35 per cent. glass for lighting purposes; also locks at top and bottom and posts so that same could be locked open as well as locked shut.

"7. Smoke-jacks so arranged that engines could be moved a quarter of a turn and equipped with suction ventilators so that the harder the wind the stronger the up draft.

"8. A system of ventilators on top of the roundhouse for catching the steam and other waste products from a locomotive.

"9. Water pipes, air pipes, blow-off pipes, steam pipes and a good-sized steam supply pipe and taps for these for each pit.

"10. A permanent, sanitary, dry floor; not a gravel or cinder floor, but a concrete foundation with wooden blocks set on edge, filled in between with tar and cement, and so fitted in as to drain any water into the pits.

"11. A toolroom for the care of all general roundhouse tools.

"12. A washroom for engine crews, lockers for their extra clothing, etc.

"13. Centrally located office and telephone facilities for the foreman.

"14. The low, flat roof of roundhouses is to be discouraged on account of the drippings in cold weather, and the impossibility of properly ventilating same."

Regarding subject "B," heating and ventilating of roundhouses, your committee can offer no suggestion for an improvement over the plant of the Lake Shore & Michigan Southern Railway, at Elkhart; this, in our opinion, being perfection itself along that line. (See description of the new Elkhart roundhouses, American Engineer, February, 1905, page 42, and March, page 80.)

The Time Service of Locomotives.

Committee—William Forsyth, H. Bartlett, J. S. Chambers, D. Van Alstyne.

It is worthy of note that the reports for time "in road service," plus the time "held at terminals ready for service," are fairly constant between 70 and 75 per cent. One road gives this figure for freight engines, accurately obtained by having special observers follow certain engines for a month, at 77 per cent.

It is reasonable to conclude from the tabulated reports that engines are ordinarily in the hands of or at the disposal of the transportation department three-fourths of the time, and this department is responsible for the large proportion of delays which so materially limit the mileage at present obtained from locomotives.

In order to obtain definite information in detail, it would be advisable to obtain accurate records at each large terminal for at least one engine in each representative run, and to do this a man

TABLE I.—TIME SERVICE OF LOCOMOTIVES ON VARIOUS RAILROADS.

Percentage of Total Time—100 Per Cent.

NAME OF RAILROAD.	On the line in Service.	At Terminal Ready for Service.	Held for Roundhouse Repairs. Heavy.	Held for Roundhouse Repairs. Light.	Shopping. Held Waiting.	Shopping. Under Repairs.
C. B. & Q. lines east of Mo. River—Average of 445 locomotives	32.	57.	.....	.....	.....	11.
C. B. & Q. lines west of Mo. River—Average of 5 locomotives	23.9	47.7	.....	28.4	.....	.....
C. B. & Q. lines west of Mo. River—Average for 11 heavy locomotives	35.6	40.3	.....	24.1	.....	.....
Lehigh Valley—Average for 12 locomotives. E. & C. Branch Auburn Division	33.	53.	3.	8.	.....	3.
Lehigh Valley—Average for 20 locomotives	67.	2.	3.	4.	6.	18.
Union Pacific. Wyoming Division—Average for 32 locomotives	45.7	18.4	6.3	11.7	5.3	12.6
Union Pacific. Nebraska Division—Average for 147 locomotives	46.	28.	4.	10.	2.	10.
Southern Pacific. Pacific System—Average for 297 light locomotives. Month of January	21.75	46.25	5.	7.	5.	15.
Southern Pacific. Pacific System—Average for 415 locomotives, weighing over 100,000 lbs.	24.	36.	3.3	10.7	4.	22.
Southern Pacific. Salt Lake Div.—Average for 40 locomotives	58.	20.	2.	10.5	.....	9.5
Oregon Short Line—Average for 156 locomotives	40.	47.	3.	.....	.....	10.
Boston & Maine—Average for 44 locomotives. Heavy and light. All classes of service; 3 months	52.4	38.9	1.3	2.8	0.6	4.0
Boston & Maine—Average for 422 locomotives. One year.	.....	.....	.....	.....	2.7	6.6
Grand Rapids & Indiana Ry.—Average for 18 locomotives, weighing over 100,000 lbs., one month	61.8	12.4	.....	16.7	.....	9.1
Grand Rapids & Indiana Ry.—Average for 19 locomotives, weighing under 100,000 lbs., one month	57.6	16.	.....	14.5	.....	11.9
Chicago, Indianapolis & Louisville R. R.—Average for 99 locomotives	47.85	34.37	2.46	7.71	0.19	7.42
C. I. & L. R. R.—Average for 41 light locomotives	60.02	20.10	1.79	11.61	0.34	6.14
C. I. & L. R. R.—Average for 19 100,000-lb. consolidation locomotives	47.11	33.45	4.96	7.79	0.15	6.54
C. I. & L. R. R.—Average for 13 ten-wheel locomotives	28.16	53.97	2.38	2.46	0.19	12.84
C. I. & L. R. R.—Average for 26 150,000-lb. freight locomotives	39.03	47.73	1.75	4.11	.....	7.38
Seaboard Air Line—Average for 319 locomotives. All classes	89.9	.....	.....	10.1	.....	.....
Norfolk & Western	86.	3.4	0.1	1.7	0.3	8.5

TABLE II.—RECORD OF LOCOMOTIVE SERVICE FOR ONE ENGINE, ONE MONTH IN FREIGHT SERVICE. JANUARY 6 TO FEBRUARY 5, 1904.

TOTAL TIME OF TEST.	Hrs.	Min.	Hrs. 714	Min. 42	Per Cent.
MOTIVE POWER.					
1. Ash Pit (divided from average of a number of timings).					
(A) Waiting to get over pit	52	51			
(B) Cleaning fires	12	06			
(C) Coal and water	31	05			
2. Time in roundhouse for repairs	55	49			
3. Engine crew late	3	57			
4. Engineman not having engine ready	1	29			
5. Late leaving ash pit	2	08			
6. Repairs to machinery unfinished	1	56			
Total time in hands of Motive Power Dept.			161	21	22.6
TRANSPORTATION.					
(A) Delays due to Transportation Dept.:					
1. Making up trains	10	00			
2. Switching	26	48			
3. Passing trains	133	14			
4. Trains ahead	40	37			
5. Orders	21	34			
6. Block	6	01			
7. Delays at R. R. crossings	1	40			
8. Yards blocked	10	24			
9. Section men	..	50			
10. Due to wrecks ahead	7	41			
11. Train crew late	..	32			
12. Waiting for orders in roundhouse	40	28			
13. Waiting on train at yards	2	01			
14. Coal and water on road	24	30			
15. Cleaning fire on road	7	33	333	53	46.8
(B) Delays due to Motive Power Dept.:					
1. Locomotives not steaming	1	23			
2. Hot bearings	1	48			
3. Drawbars	4	27			
4. Couplers	1	22			
5. Cleaning front end	..	30			
6. Due to air brakes	4	13	13	43	1.9
(C) Running time, not including taking coal and water on the road	205	39	205	39	28.7
Total time in hands of Transportation Dept.			553	15	77.4
AT ENGINEHOUSE.					
1. Ash pit	96	02			
2. In house for repairs and care	59	53			
3. Detained at house waiting for crew	5	26			
4. Waiting at house for orders	40	28			
Total			201	49	
AT YARDS.					
1. Making up trains	10	06			
2. Putting away trains	5	12			
3. Waiting on trains and orders	3	28			
4. Yards blocked	17	55			
5. Block	2	41			
6. Motive power delays	2	16			
7. Running time between house and yards	6	53			
Total				31	
ON ROAD.					
1. Passing trains	128	36			
2. Trains ahead	37	44			
3. Switching	21	36			
4. Orders	20	07			
5. Block	3	20			
6. Miscellaneous	10	43			
7. Cleaning fire and taking coal and water on road	32	03			
8. Motive power delays	11	27			
9. Running time	198	46			
Total			464	22	
Grand total			714	42	

Total mileage on road	3129.	miles.
Average running speed (miles per hour)	15.2	"
Average equivalent speed for transportation time	5.7	"
Average equivalent speed for total time of test	4.4	"
Mileage on fast freight	348.	"

Distribution of Time Waiting for Orders in Enginehouse.

	Per Cent. of Total Time.	Hrs.	Min.	No. of Times at House.
At Terminal A	40.	16	13	9
At Terminal B	34.6	14	00	7
At Terminal C	25.4	10	15	7

TABLE III.—RECORD OF LOCOMOTIVE SERVICE FOR ONE ENGINE, ONE MONTH IN FREIGHT SERVICE.—JANUARY 6 TO FEBRUARY 5, 1904.

SUMMARY.	Hrs.	Min.	Per Cent.
Charged to Motive Power—At Roundhouse:			
Waiting to get over ash pit	52	51	
Cleaning fires	12	06	
Coal and water	31	05	
Total	96	02	
In roundhouse for repairs	55	49	
Minor delays due to men	9	30	
Total time in hands of Motive Power Dept.	161	21	22.6
TRANSPORTATION.			
Making up trains	10		
Switching	26	48	
Passing trains	132	14	
Trains ahead	40	37	
Orders	21	34	
Yards blocked	10	24	
Wrecks	7	41	
Waiting at roundhouse for orders	40	28	
Coal and water on road	24	30	
Cleaning fire on road	7	33	
Sundry small delays	12	04	
	333	53	46.8
Delays due to M. P.—Not steaming, hot boxes, drawbars, brakes	13	43	1.9
Running time	205	39	28.7
			100.
Total time in hands of Transportation Department	553	21	77.4
Time at enginehouse	201	49	
Time at yards	48	31	
Time on road	464	22	
	714	42	
Running time	198	46	

must be especially assigned to the engine and keep accurate record of the time of all its movements.

To show the detail into which such a report can be divided, an actual record is here given of the complete time service of one locomotive for one month in freight service. It will be seen that the total time in the hands of the motive power department was 22.6 per cent., and in the transportation department 77.4 per cent., and that the delay due to motive power while on the road constituted but 1.9 per cent. of the total time. The average running speed was 15.2 miles per hour, but the total mileage, divided by the time in the hands of the transportation department, is equivalent to only 5.7 miles per hour, and the average equivalent speed for the total time of test, 4.4 per hour.

Your committee is of the opinion that records relating to the time service of locomotives are worth keeping in considerable detail, and that numerous delays can be checked up in this way which do not appear to be noticed or obtained by ordinary methods.

Subjects for 1906.

Committee—J. F. Deems, William McIntosh, R. D. Smith.

INDIVIDUAL PAPERS.

1. The more general application of white metals for bearings of locomotives.
2. Special valve gears, such as the Walschaert, Alfree-Hubbell, Young, etc., compared with the ordinary Stephenson link motion, by C. J. Melin.
3. Fire kindling; cost of material, labor and time kindling fires in locomotives, with both anthracite and bituminous coal, by F. F. Gaines.
4. Superheating steam in locomotive practice, by F. J. Cole.

SUBJECTS AND COMMITTEES.

Best method of welding and repairing locomotive frames without taking down or removing from the engine.—William Garstang, C. H. Quereau, G. W. Wildin.

Organization of the Mechanical Department, with special reference to the question as to whether the Mechanical Department or the Transportation Department should employ, examine, promote, govern and discipline locomotive firemen and engineers.—D. Van Alstyne, J. H. Manning, G. M. Basford.

What can be done to establish a general understanding of a uniform method of designating repairs on locomotives in railroad repair shops, in order that reliable comparisons can be made as to the efficiency of various shops on any one system, or possibly as between the shops of various systems or roads.—H. H. Vaughan, R. Quayle, C. W. Cross.

Engine house running repair work on locomotives; what is considered the best practice for doing this work, handling reports, etc., made by foremen, engineers, road foremen of engines, and inspectors, and with what machine tools and hand tools should the roundhouse be equipped to get the best results?—A. E. Mitchell, F. T. Hyndman, J. W. Luttrell.

Locomotive lubrication; general consideration of the subject, with reference to high steam pressures and superheated steam; how far may we economize in lubrication, both internal and external; also consider standard fittings for lubricators; consider question of sight-feed lubricators versus pumps for internal lubrication.—E. D. Bronner, R. F. Kilpatrick, D. Van Alstyne.

Specifications covering cast iron to be used in cylinders, cylinder bushings, cylinder heads and steam chests; also the question of substitution of cast steel for locomotive cylinders, the idea being to secure lighter section with better material.—G. R. Henderson, E. D. Nelson, Max Wickhorst.

Results obtained from water-purifying plants.—L. H. Turner, H. T. Bentley, W. R. McKeen.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Tests of M. C. B. Couplers.

Committee—R. N. Durborrow, J. Buker, W. S. Morris, W. P. Appleyard, F. H. Stark.

The question of the adoption of a standard design of automatic coupler was forcibly brought out by the president in his address before the convention last year, and was later referred by the Executive Committee to your Coupler Committee for consideration. As this is probably the most important coupler question which has come before the Association since the adoption of the M. C. C. contour lines in 1888, there can be no doubt that there is urgent need for some concerted action by the railroads of the country looking toward a reduction of the large number of types of couplers now in use, with a view of eliminating those of weak design and poor construction. The large sums of money invested in the great variety of coupler parts necessary to carry in stock at repair yards is alone a convincing argument that some action should be taken to relieve the present conditions.

The ideal arrangement would be the universal use of but one design of coupler, and the future policy of the association must depend upon the question as to how near and in what manner to approach this ideal. After deliberate consideration of the various phases of this subject, your committee has concluded that it would be best not to offer any definite recommendation as to the policy to be adopted; but it would suggest that the association consider the following schemes in whatever action may be taken:

First. That the Coupler Committee be empowered to act in conjunction with a specially appointed committee (in which should be included representatives of the manufacturers) to early decide upon a composite design of coupler which shall contain as far as possible the desirable features of the best couplers as now designed, and that all patent rights involved be waived and all manufacturers be permitted to manufacture the composite coupler as adopted.

Second. That the present policy of the association be followed out—that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency, and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competition.

In presenting this subject your committee asks for a full discussion at the present convention and urgently requests that immediate action be taken to formulate definite instructions to the Coupler Committee as to the policy to be pursued. Your committee deems this subject of vital importance and believes that it should not be delayed.

The specifications for M. C. B. couplers have been used, in practically their present form, since 1901, and are to-day giving satisfaction as a check on the design, workmanship and the material in couplers. That good results have not been universally felt is due to the reluctance of the railroads to buy their couplers under these specifications; although the specifications are far from being in general use, it is the opinion of your committee that the time has come when action should be taken by the association looking toward enforcing their use.

The large number of break-in-twos, nearly all of which can be attributed to coupler failures, is abundant testimony to the fact that many couplers are not what they ought to be; and anything to improve them should be eagerly taken up. The earlier the railroads can be induced to use these specifications the earlier will an important step have been taken toward a decrease in the number of these break-in-twos, and the consequent expensive accidents.

Believing that the present annoyance from coupler failures demands some acton, and that the results will justify the action, your committee recommends that the specifications for M. C. B. couplers, which are at present recommended practice, be advanced to standard as a step toward enforcing a higher efficiency in our couplers and relief from delays to traffic due to their failure. Making the specifications a standard of the association will necessitate some minor changes in their reading to avoid repetition of features already standard.

Recommendations.—1. Present specifications for M. C. B. couplers, which are now recommended practice, with the modifications and additions suggested in the body of this report, be made standard.

2. Worn coupler limit and wheel defect gauge (Drawing "A") be adopted as standard, superseding wheel defect gauge on M. C. B. sheet 12, and annulling worn coupler limit gauges shown on M. C. B. sheets "A" and "G."

3. Knuckle designed not to pull out when knuckle pin fails be adopted as recommended practice.

4. Knuckle throwing device be adopted as recommended practice.

5. Knuckle lock lift to be in the central longitudinal vertical plane, located between the striking horn and contour lines, and operate from the top by an upward movement, be adopted as recommended practice.

6. That the additional dimension, "Not less than 20¾ ins." be added on the plan view of 5 x 7-in. coupler on M. C. B. Sheet 11,

to definitely locate the point at which the shank shall measure 7 ins.; this dimension will prevent designers from moving the 1-in. radius (connecting the head and the shank) back too far, thus reducing the lateral coupler clearance in the carrier iron below the prescribed limits.

7. That the coupler "Tail End for Continuous Draft," shown on M. C. B. Sheet 11, be removed as being unsuited for approved practice in car construction, as recommended by the Committee on Draft Gear in its report to the convention of 1904.

8. The enlarged butt for the 5 x 7 shank from friction gear, as shown on Drawing "C," (not reproduced) be adopted as recommended practice, to conform to the yoke for butt, recommended by the committee on Draft gear last year.

Air-Brake Hose.

Committee—L. G. Parish, T. S. Lloyd, F. H. Scheffer, G. H. Emerson, J. Milliken.

Your committee submits herewith report covering results of tests at Purdue University to determine the condition of hose in service at various ages. This report covers a total of 500 hose which were removed from actual service and tested. The laboratory report gives a full description of the testing plant and describes the manner in which the hose were tested; also the age of hose, the manufacturer's name and brand. A study of the data herein given leads the committee to recommend the submission of the specifications proposed last year to the convention as a standard in lieu of the present M. C. B. standard specifications for hose.

The committee would reaffirm the recommendation made in the report last year, i. e., that the location of the angle cock and train pipe has not been given proper attention. The M. C. B. recommended practice specifies that train pipe be located thirteen (13) ins. from the center line of car, and that the angle cock be turned to an angle of thirty (30) deg. Your committee would again recommend that this be made a standard.

Attention is called to the necessity of having the air brake pipe securely fastened, to prevent vibration. These features are not being watched as closely as they should. The improper location of the train pipe and angle cock brings about a condition fully as bad as pulling cars apart without uncoupling hose by hand. The standard 22-in. hose is of sufficient length if the angle cock and train pipe are located as per M. C .B. recommended practice. If, however, the train pipe is located over 13 ins. away from the center line of car, and the angle cock vertical, the distance is greatly increased, and when the slack is taken out of the couplers the hose is ruptured, on account of vertical strain. The laboratory tests indicate that the majority of burst hose is due directly to the conditions mentioned above.

The committee would recommend to the Arbitration Committee the incorporation of the following rule in the Rules of Interchange:

"On and after March 1, 1908, cars offered in interchange must be equipped with M. C. B. standard hose; if not so equipped owners are responsible for the application of standard hose."

The committee would recommend that 2,000 additional hose be tested during the coming year in order to definitely determine the age limit of air brake hose. Attention is called to the fact that we have at Purdue University an air brake hose testing plant which is available for the use of our members.

Truck Arch Bars for 100,000-lb. Marked Capacity Freight Cars.

Committee—J. E. Muhlfeld, A. S. Vogt, W. T. Gorrell, C. E. Fuller, F. M. Gilbert.

Your committee on this subject submits the following report:

Realizing the wide difference in opinion of railroad mechanical men with respect to the various types of truck arch bars in use on freight cars, the weight of which, including lading, is 150,000 lbs., it was decided to submit a list of questions to all members of the association for the purpose of obtaining data and information pertaining to the practice of railroads operating under similar and different conditions.

Replies to the circulars of inquiry were given by 14 railroads and car builders, and from the information received, your committee suggests that the following conclusions shall be submitted to the convention for adoption:

The Distance Between Wheel Centers to Be 5 Ft. 6 Ins.—Ten replies out of the total number received specified this spacing, which your committee considers necessary to provide a sufficient amount of room for a substantial design of truck bolster and column castings, and for the proper suspension of inside brake beams and application of brake heads and shoes.

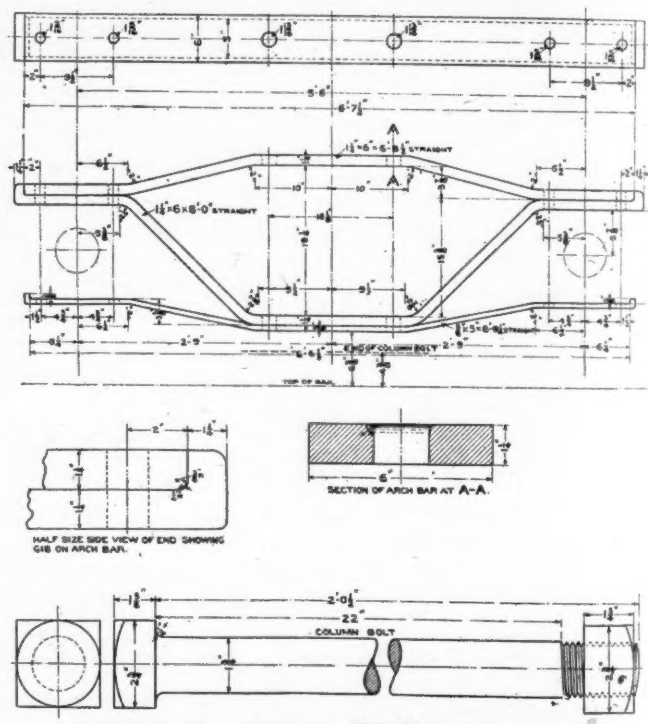
The Cross Section of the Top and Inverted Arch Bars to Be 6 x 1¼ Ins.—The tendency has been, and will be, to increase the average loading per car, especially in the vicinity of the coal, ore, structural steel, quarry and other districts where business originates which will necessitate the use of the greatest proportion of 100,000 lbs. and heavier capacity equipment. It has been found that sections of inverted arch bars 5 x 1¼ ins. have failed within a few years after having been put into service. These failures have occurred principally in the bends at the base of the column castings and through the column bolt holes, and an examination has indicated that even with a good quality of wrought iron material and proper truck construction detail and entire fractures have developed at these points. Furthermore, the column bolt holes have shown a slight tendency to elongate, with a corresponding reduction in the thickness of the section, indicating that there is not sufficient metal at this point for the stress. The replies, as well as the practice in vogue at the present time, indicate the necessity for making use of a section larger than 5 x 1¼ ins., and in order to provide for the best distribution of metal at the weakest point in the inverted arch bar, it has been thought advisable to increase the width to 6 ins. The reasons for increasing the cross sectional area by widening rather than by thickening the arch bars are, greater strength with equivalent weight, more lateral stiffness, reduced liability for over-straining, less distortion of cross section in forming, greater uniformity in the section and quality of material, and reduced expense for construction and maintenance. It is not considered necessary to have a larger section of top arch bar than inverted arch bar, and the advantage to be derived from making both sections of the same dimensions is apparent.

The Section of Tie Bar to Be 5 x ⅝ Ins.—Seven of the replies received specify the use of tie bars 5 x ⅝ ins., and from the general information given, as well as the results from practice, it is thought that this section will be entirely satisfactory in connection with the 6 x 1¼-in. arch bars.

The Inverted Arch Bar to Be Gibbed to Provide a Bearing for Each End of the Top Arch Bar.—This practice is recommended, as from service and drop and other tests, it has been found that a bearing for the ends of the top arch bar against the ends of the inverted arch bar will produce greater stability, provide for the maximum benefit from the top arch bar, and at the same time reduce the shearing effect on the journal box bolts. It will also increase the strength and stiffness of the arch bar frame as a whole and give a greater factor of safety under the increasing average loads to be carried.

The Tie Bars to Be Gibbed at the Ends.—This practice is recommended for the reason that service records indicate that the wear on the threaded portion of the journal box bolts and the elongation by wear of the journal box bolt holes in the tie bar have been considerably reduced where the gibs were used, and this result is considered an advantage that will justify the application of this feature.

The Set of the Top Arch Bar to Be 3⅞ Ins.—From the replies received, three specify the use of the 3⅞-in. dimensions, two



PROPOSED ARCH BARS FOR 100,000-LB. FREIGHT CARS.

3¾ ins., and the others vary from 1 to 5 ins. The five railroads using the 3⅞-in. and 3¾-in. set represent a freight equipment of 334,645 cars, of which 71,355 cars are 100,000 lbs. capacity.

The Distance Between the Top and Inverted Arch Bars to Be 19¼ Ins.—General design and practice have indicated that this dimension is the proper one to be used with the set of 3⅞ ins. for the top arch bar, and in connection with the M. C. B. truck bolster spring, in order to provide for sufficient depth and strength at the end of the truck bolster, as well as space for a substantial spring seat which will clear the through bolts securing the ears of the column castings to the spring channel.

The Set of the Inverted Arch Bar to Be 15⅝ Ins.—The set of the top arch bar and the distance between the top and inverted arch bars having been determined, the above dimensions must follow.

The Set of the Tie Bar to Be 3⅜ Ins.—This dimension is determined by the M. C. B. journal box.

The Distance from Center to Center of Column Bolt Holes to Be 16⅛ Ins.—This spacing has been found sufficient to provide for a suitable design of truck bolster giving ample transverse strength. It will also provide for sufficient strength in either cast iron, malleable iron or cast steel column castings, and accommodate the use of M. C. B. bolster springs.

All Column and Journal Box Bolt Holes to Be 1-16 In. Larger Than the Diameters of the Bolts.—This will conform to the established practice.

THE DISTANCE BETWEEN THE TOP OF THE TRACK RAILS AND THE BOTTOM OF THE TIE BAR TO BE 6⅜ INS.—It is thought that the above dimension should be adopted to provide the necessary space for the M. C. B. bolster springs and substantial truck bolsters, and give sufficient clearance between the top of the bolster and the under side of the top arch bar.

THE DISTANCE BETWEEN THE TOP OF THE TRACK RAILS AND THE LOWER END OF THE COLUMN BOLTS TO BE NOT LESS THAN 4⅜ INS.—The features considered in the establishing of this distance are the required clearance at road crossings, for Wharton type switches, etc., and allow for the usual wear of journal bearings, journals, treads of cast iron wheels, and for the reduction in diameter of steel-tired and rolled-steel wheels.

THE DIAMETER OF THE COLUMN BOLTS TO BE 1¾ INS. AND THESE BOLTS TO BE FITTED WITH COMBINED WASHERS AND NUT LOCKS AT THE HEAD OF THE BOLT AND AT THE NUT, AND WITH THE UNITED STATES STANDARD SQUARE HEADS AND NUTS. THE TOP ARCH BAR TO HAVE THE COLUMN BOLT HOLES COUNTERSUNK ON THE UPPER SIDE TO TAKE A ¼-IN. RADIUS FILLET UNDER THE HEAD OF THE COLUMN BOLT . . .

THE RADII AT THE BENDS OF THE TOP ARCH BAR TO BE 2 INS., AND TO THE INVERTED ARCH BAR AT THE COLUMN CASTING 2⅞ INS.

THE RADII OF THE INVERTED ARCH BAR AT THE JOURNAL BOX TO BE 2¼ INS.

ALL OTHER DIMENSIONS TO CONFORM TO THE PRESENT M. C. B. STANDARDS.

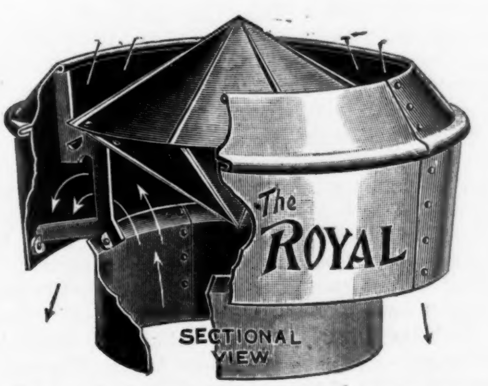
THE MATERIAL PREFERABLE FOR ARCH AND TIE BARS AND COLUMN BOLTS IS GOOD WROUGHT IRON, THIS BEING BETTER ABLE TO WITHSTAND DISTORTION WITHOUT DETAIL OR ENTIRE FRACTURE.—When the best quality of wrought iron is not attainable, a good medium carbon, low phosphorus and sulphur, open-hearth steel can be used for arch and tie bars. The use of Bessemer steel is not recommended under any circumstances.

GENERAL.—The cuts as shown by Plate No. 1 accompanying this report show a top and inverted arch bar, tie bar and column bolt of the recommended design and dimensions for cars, the weight of which, including lading, is 150,000 lbs., as well as for modern freight and switching locomotive tenders, where the use of helical springs is permissible. With the use of the four coil nest of helical springs and a substantial spring seat casting and channel there is no necessity for any additional reinforcing over the inverted arch bar between the truck column castings.

Your committee believes from a general standpoint that the recommended design and specifications as included in the eighteen sections and Plate 1 can be adopted with satisfactory results, and provide for the greatest strength and factor of safety to resist the stresses due to ordinary wear and tear, curvature, lateral thrust, braking action and derailment.

VENTILATION.

The accompanying illustration shows the construction of the Royal ventilator which has proved very successful in ventilating buildings, power houses, train sheds and factories. The construction is very substantial and the design is such that rain and downward currents of air are deflected without materially interfering with the free egress of air from the interior and it is always effective when the wind blows and will not choke in a calm. The diameter of the upper cone is enough greater than that of the lower one to deflect rain and



SHOWING CONSTRUCTION OF ROYAL VENTILATOR.

snow outside of the neck of the ventilator. The lower cone deflects the upward current of air from the body of the ventilator and in so doing offers only a very slight resistance and does not produce choking eddies or counter currents. In the larger ventilators patent radiating ribs are formed in the cones which make a very rigid construction and add greatly to the ventilating capacity. No matter which way the wind blows an exhaust current of air is induced from the building. Because of the large area of discharge a comparatively small number of these ventilators are required to properly ventilate a building. They are made by the Royal Ventilator and Manufacturing Company of Philadelphia.

HEAVY TONNAGE.—The average tonnage carried per mile of road on the Pittsburgh & Lake Erie Railroad last year was 121,607 tons, or almost twenty times greater than the average tonnage per mile carried on all the railroads of this country for a corresponding period.

COMPRESSION IN STEAM CYLINDERS.—The following is taken from a review in *The Engineering Magazine* of an article by Dr. Herbert Klemperer in the *Zeitschrift des Vereines Deutscher Ingenieure*, which reports and discusses some very careful tests made at the technical high school in Dresden. Dr. Klemperer states: "The condition under which compression is advantageous is that the temperature at the end of the compression shall not exceed that of the cylinder walls, so that the maximum economical compression at the end of the stroke is that corresponding to the temperature of the walls." If the compression is increased beyond this point the economy of the engine will fall off, and according to the experiments at Dresden, the steam consumption will increase in proportion to the ratio of the volume of the compressed steam to the volume of live steam in the cylinder.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

SAFETY VALVES.—The American Steam Gauge & Valve Manufacturing Company of Boston, are sending out a circular which contains an interesting description of the American special pop safety valve.

FROGS, SWITCHES AND CROSSINGS.—A 375 page catalog has just been received from the Weir Frog Company, Cincinnati, O., manufacturers of frogs, switches, crossings and all kinds of regular and intricate track work.

SOME REASONS WHY.—The Otto Gas Engine Works, Philadelphia, Pa., have issued a folder which describes in an interesting manner the advantages of their gas engines and calls attention to several good reasons why buyers should select these engines.

ELECTRIC GENERATORS.—The Crocker-Wheeler Company, Ampere, N. J., are sending out bulletin No. 53, which describes their direct current, lighting and power generators, and also bulletin No. 55 on small generators arranged for direct connection.

EXHAUST FANS.—Catalog No. 180 from the American Blower Company, of Detroit, Mich., describes their "A B C" exhaust fans which are specially designed for the removal and conveying of shavings and dust, the removal of smoke and fumes, and for use in connection with special heating and drying plants.

TABOR INDICATOR.—We have just received from the Ashcroft Manufacturing Company, 87 Liberty Street., New York, a catalog describing the latest type of Tabor Indicator; also the Houghtauling reducing motion, the Ashcroft reducing wheel, the Coffin averaging planimeter and various indicator parts and supplies.

THE LEWIS & CLARK EXPOSITION.—The Westinghouse Electric & Manufacturing Company have issued a very attractive pamphlet for distribution at this exposition at Portland, Ore. It illustrates and briefly describes the line of apparatus manufactured by this company, specially referring to the apparatus on exhibition and to actual installations of apparatus.

PROGRESS REPORTER.—The July number of the "Progress Reporter," published by the Niles-Bement-Pond Company, New York, briefly describes and handsomely illustrates some of the machine tools furnished by this company for the Angus Shops of the Canadian Pacific Railway at Montreal. Interesting facts are presented concerning the output of some of the machines.

ELECTRIC GRINDERS AND BUFFERS.—Bulletin No. 48 from the Northern Electric Manufacturing Company, Madison, Wis., describes the various Northern electric grinders and buffing equipments which are equipped with speed regulating devices so that the speed may be varied to compensate for the varying diameters of the wheels. These grinders are of special design and construction and have heavy crucible tool steel armature shafts, liberal bearings and dust-proof covers.

JEFFREY SCREENS.—The Jeffrey Manufacturing Company, Columbus Ohio, have just issued a supplement to their screen catalog N. 69.

PLANERS.—The Cincinnati Planer Company, Cincinnati, O., has issued an attractive catalog describing its line of planers which has been completely redesigned. Special attention is directed to the devices which they furnish for obtaining a variable cutting speed with a constant return speed. There is also a valuable chapter on the erection and care of Cincinnati planers.

DON'T BURN MONEY.—A pamphlet of 12 pages, issued by William B. Scaife & Sons Company, 221 First avenue, Pittsburgh, Pa., presents engravings illustrating the application of the Scaife or We-fu-go system of water purification. These applications are for railroad and manufacturing service, indicating the progress which has been made by this company in introducing this system.

ROTARY PLANING MACHINES.—Catalog No. 41 from the Newton Machine Tool Works, Philadelphia, Pa., describes a number of their rotary planing machines, which are made in various sizes, having cutter-heads from 26 to 100 ins. in diameter over the tools, and which are made either plain, portable, on circular sub-base or mounted on a long bed to face off both ends of the work simultaneously. A number of special machines are also shown.

GRINDING MACHINES.—"A Treatise on Tool Room Grinding and Grinding Machines" has just been published by the Cincinnati Milling Machine Company. It describes their No. 1 universal cutter and tool grinder and also their No. 2 machine which has been designed especially for sharpening the large spiral and face mills. Directions are given for the care and operation of these machines and a large number of illustrations show how various operations are performed. It also contains valuable information concerning reamer clearances and emery wheels.

AXLE LIGHT SYSTEM.—Bulletin No. 1 from the Consolidated Railway Electric Lighting and Equipment Company, 11 Pine Street, New York, contains an interesting description of their axle light system of electric lights and fans for passenger cars. That this system is giving satisfactory results is shown by the fact that a list is given of twenty of the largest railways in this country, who use this system of electric lights and fans on many of their best cars. In addition the officers cars on many of the other leading railroads, as well as all Pullman private cars, are equipped with it.

NOTES.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.—The Los Angeles, California, office of this company has been removed from the Trust Building to 527 South Main Street.

CRANE COMPANY.—This company has moved its general offices and sales departments to its new office building at 519 South Canal street, Chicago, near the Judd street plant.

AMERICAN WATER SOFTENER COMPANY.—During the month of June this company received two orders for water softening plants from the Norfolk and Western Railroad, to be installed in their coal lands in West Virginia. This makes a total of three orders from the railroad company since April 1st.

THE CRANE COMPANY.—This company celebrated its 50th anniversary on July 4th. All of the company's branch house managers took part in the celebration, and the festivities lasted for four days. As a souvenir of the anniversary the company is sending out metal elephants to be used as paper weights.

BIG CRANK SHAFTS.—The Bethlehem Steel Company is at work on three crank shafts which will weigh 86,600 lbs. each when finished. They are turned out of solid steel ingots 25 x 4 x 4 ft., and are intended for three Snow gas engines, which are to drive 4,000-k.w. Crocker-Wheeler alternators, the largest gas engine driven generators ever built, ordered by the California Gas and Electric Corporation.

SCALING PIPES BY PNEUMATIC HAMMERS.—A valuable discovery in scaling and cleaning pipes, particularly of condensers, is that a pneumatic hammer striking rapid, uniform, light blows is better than anything else which has been devised. It does not crack the pipes, or spring the joints and requires about one-fourth the time to clean a condenser involved in old methods. Mr. A. P. Anderson, of the Consumers' Ice Company of Chicago, has used the pneumatic hammer very successfully in this service, our attention having been called to this fact by the Chicago Pneumatic Tool Company of Chicago.

THE WARNER & SWASEY COMPANY.—Mr. G. D. Mitchell, formerly of the United Shoe Machinery Company, but better known as the Jones & Lamson expert, with which company he has been connected for the past five years, has just become associated with The Warner & Swasey Company, in the capacity of western representative.

WILLIAM B. SCAIFE & SONS COMPANY.—This company has been awarded the contract for all the structural steel work in connection with the Port Falls, Idaho, power plant to be built for the Washington Water Power Company of Spokane. They have also designed and will erect a steel frame trestle approach 200 ft. long for the American Lime and Stone Company at Frankstown, Pa.

CROCKER-WHEELER COMPANY.—This Company has declared a regular quarterly dividend of 1½ per cent. and re-elected the following officers: Schuyler Skaats Wheeler, President; Gano S. Dunn, Vice-President and Chief Engineer; W. L. Brownell, Treasurer; G. W. Bower, Assistant Treasurer. The directors are Professor Francis B. Crocker of Columbia University; Dr. Wheeler, Messrs. Dunn and Doremus, A. Foster Higgins, Herbert Noble, Thomas Ewing, Jr., F. L. Eldridge and C. A. Spofford.

INDEPENDENT PNEUMATIC TOOL COMPANY.—This company recently acquired the Aurora Automatic Machinery Company of Aurora, Ill., makers of the Thor piston air drills; pneumatic riveting, chipping, caulking and beading hammers; piston air motor hoists; pneumatic saws and other air appliances. The general offices of the Independent Company are in the First National Bank Building, Chicago, Ill., and the Eastern office is at 170 Broadway, New York. The works at Aurora, Ill., are equipped with the very latest improved machinery, the present capacity being about 100 pneumatic tools per month. The officers and board of directors include a number of names very well known among the railroad and machinery supply interests.

FARLOW DRAFT GEAR.—The Farlow Draft Gear Company exhibited at the Master Mechanics' and Master Car Builders' Association conventions a full-size model, showing the combination of the Westinghouse draft gear with Farlow attachments. This exhibit received much favorable comment, and this draft gear itself received noteworthy recognition in the Master Car Builders' convention in connection with the decision not to abandon the slots in coupler shanks. This gear has been described in this journal and its special features pointed out. It is so designed that the parts may be assembled and applied by one man. The riveted yokes and follower plates are eliminated, and the stresses are distributed throughout the length of the draft sills from the end sill to the body bolster. The initial stress, to the extent of the capacity of the friction device, is received by the rear key and filler block. After the coupler has travelled 2½ ins. the horn comes into the bearing against the buffer plate. The front key has then travelled to its bearing on the cheek plate, and the front block has travelled from the center key to its bearing upon that key; this makes six seperate points of contact for the distribution of the stresses. In pulling, the front and rear keys travelling ahead of the bearing in the cheek plates, the middle key being stationary. The load is therefore carried to the draft sills at three separate places. In either pulling or buffing the coupler is free to adjust itself laterally.

LAKE MEMPHREMAGOG.—This lake, in Northern Vermont and Canada, is one of the most charming resorts in the Green Mountain State. This lake is 30 miles long and 2¼ miles wide, and over two-thirds of its length is in Canada. In early days a favorite haunt of the Indians for fishing and camping; it was named by them Memphremagog, meaning "beautiful water." The steamer "Lady of the Lake" leaves Newport sailing the entire length of the lake to Magog, occupying about four hours. The view as witnessed from the decks of the steamer is magnificent; the charms of the rocky and uneven shore; the towering cliffs, the long stretches of green forest land and the distant peaks of Owl's Head and Oxford Mount, with intervening sweeps of beautiful valley land, present a panorama which appears more beautiful at every turn. The "Switzerland of America" this region has been called, and many people see in Memphremagog another Loch Lomond, while the Canadian portion has frequently been termed the "Geneva of Canada." In order to get a comprehensive idea of the marvelous scenic surprises of this region send two cents in stamps to the general passenger department, Boston & Maine Railroad, Boston, for their beautiful illustrated booklet, entitled "Lake Memphremagog and About There," and two cents for the companion booklet, entitled "Valley of the Connecticut and Northern Vermont."